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R-1754-PR

October 1975

The U. S. ICBM Force: Current Issues and Future Options (U)

C. H. Builder, D. C. Kephart, A. Laupa

A Report prepared for

UNITED STATES AIR FORCE PROJECT RAND

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SANTA MONICA, CA. 90406

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PREFACE

This is a summary perspective of the U.S. ICBM force. The purpose is to provide decisionmakers at all levels with a short but comprehensive background appreciation of the key issues and options that have become associated with land-based ICBMs. The material should be useful in helping to support a wide range of decisions affecting the future composition of the U.S. ICBM force. While the individual topics are not developed in detail sufficient for specific decision situations, they do cover a span of concerns and alternatives going beyond what is usually found in any single report or briefing on the force.

Providing a short yet comprehensive review has enforced some economies in the selection of material. Since the intended readers are likely to have more than a pedestrian knowledge of ICBMs, the aim is to remind rather than to educate. The tutorials are limited to those issues and options that seem to pivot on details not widely discussed in the open literature. The discussions do not go very much beyond the U.S. ICBM force, even though many of the subjects invite, if not demand, broader consideration of related topics such as the Soviet ICBM force, alternative strategic forces, and national security objectives. These related topics are omitted unless they seem peculiarly relevant to the U.S. ICBM force. It is presumed that the audience is familiar with these broader questions.

The report was prepared as a task on the continuing Project RAND study entitled "Future Strategic Aerospace Force Requirements."

SUMMARY

This report presents a broad review of issues and alternatives bearing on the future of the U.S. ICBM force. The purpose is to provide a background understanding and a perspective to help support decisions on force structure and deployment. The historical evolution, current status, and ongoing plans for the force are briefly summarized, serving as a compact reference source and introduction to the U.S. ICBMs. Issues associated with ICBMs in the public debates are developed, together with outlines of the principal opposing arguments. Future options, beyond those now programmed for the force, are identified and discussed.

At the end the authors present their own subjective assessment of the key issues and options. They hold that the unresolved pivotal issue bearing on the future of the ICBM force is whether or not it will evolve to play any unique roles in our strategic posture. The future does not look promising if ICBMs are viewed simply as an arm of the Triad--one of three ways of doing the same job. The authors believe however that ICBMs could emerge preeminent for special roles in at least four areas. These include ICBMs fitted for limited strategic operations, ICBMs as a cost-effective strategic reserve, ICBMs for counterforce, and ICBMs for "force equivalence."

ACKNOWLEDGMENTS

The authors appreciate the contributions of Rand colleagues W. A. Barbieri, C. M. Crain, J. L. Foster, T. B. Garber, V. G. Jackson, F. S. Nyland, D. V. Palmer, A. I. Robinson, R. D. Shaver, H. Shulman, and E. Taylor, who provided helpful inputs, comments, and advice during the preparation of this report.

CONTENTS

I. INTRODUCTION

The years just ahead are likely to be crucial in determining the long-term future of the U.S. ICBM force. The mounting pressures for changes in the force are numerous, diverse, and conflicting. The decisions to be faced vary in importance, scope and complexity, but collectively they should have a pervasive impact upon the kind of ICBM force that will emerge in the 1980s. The purpose of this report is to outline a broad context for these impending decisions.

The division of this summary perspective between current issues and future options is an artificial and not entirely satisfactory convenience. Obviously, many issues and options are as intimately associated as a problem and its solution. But we observe more often that a single option may address several issues. Also, we are persuaded that complete discussions of the problems and separate discussions of the potential solutions provide a better perspective for judgments about their relative importance.

While preparing this summary perspective, the authors have formed their own judgments on the issues that are most important and the options that seem promising. We recognize an obligation to share these judgments because of what they may reveal about our own biases and because of the vantage point we have enjoyed. For that reason, a final separate section is included to present our subjective assessments of the crucial issues, the responsive options, and the outlook for the U.S. ICBM force. As such, those assessments reflect the views and judgments of the authors, not necessarily those of our readers.

To provide a basis for discussing the current issues and future options for the U.S. ICBM force, we must first establish a common perception of the *present* force. The remainder of this section is a review of the present ICBM force: what it is, how it came to be, and where present plans will take it. This compact recital of facts should serve as a useful reference guide even for those who are most familiar with the U.S. ICBM force.

CURRENT ICBM FORCE

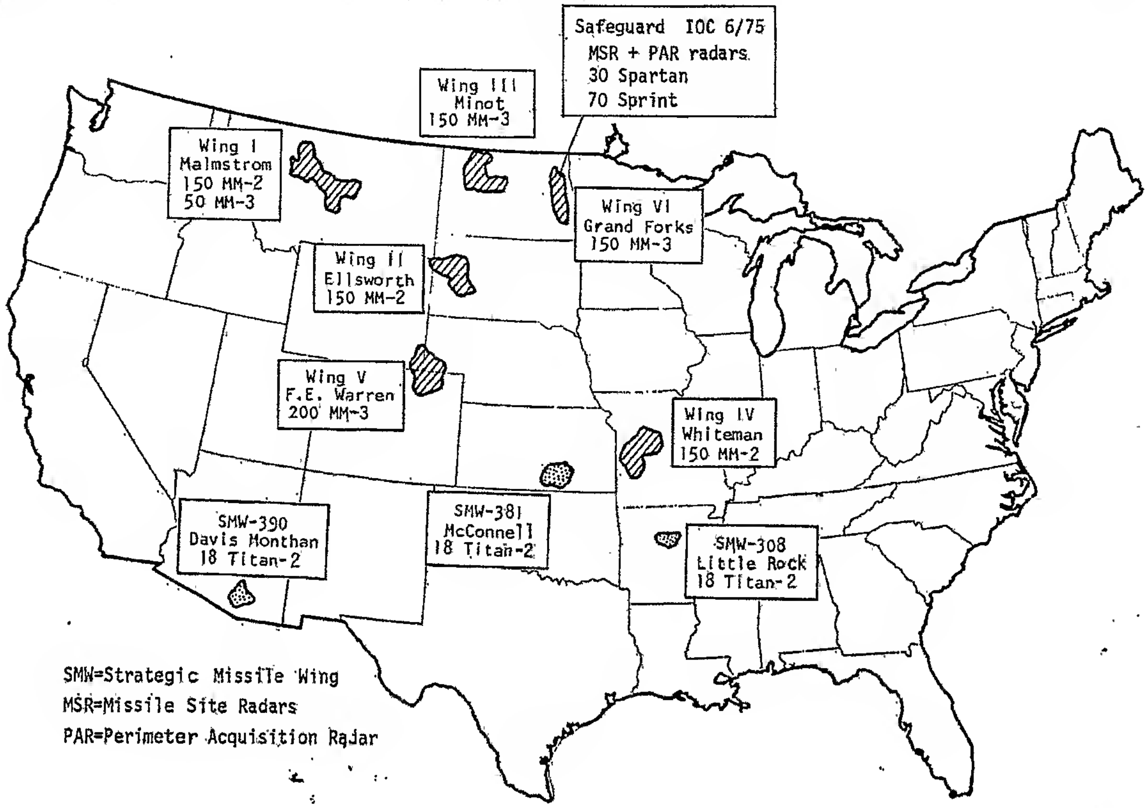
(U) The U.S. ICBM force consists of 1000 Minuteman and 54 Titan missiles operationally deployed in hardened underground launchers at nine CONUS sites as shown in Fig. 1, with Minuteman command control netting as in Fig. 2. The principal features of the force are summarized in Fig. 3. Vehicle characteristics are summarized in Table 1.

~~(S)~~ Titan 2 is deployed in six 9-missile squadrons at three wing locations. Each missile is on continuous alert with its own co-located maintenance-qualified launch crew. With a throw-weight capability more than 4 times that of Minuteman 3, Titan 2 is readily adaptable to a variety of special tasks including FOBS, and lofted or depressed flight paths. Titan 2 trajectories will reach the PRC without overflying Soviet territory. As a MIRV launcher Titan 2 could deliver about five Minuteman 2 warheads.

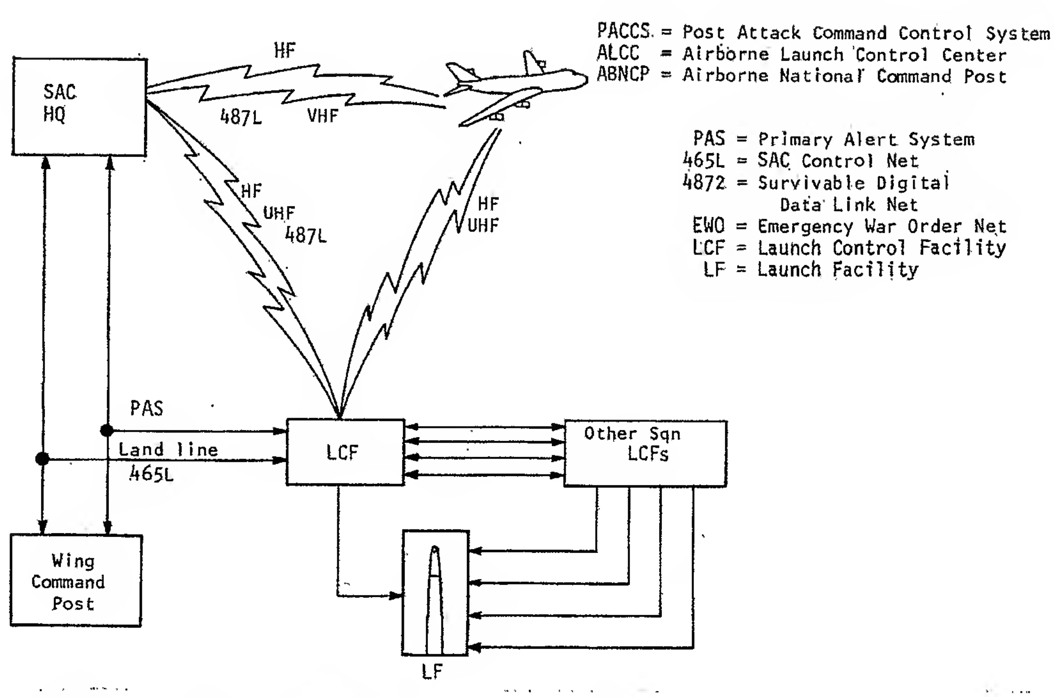
~~(S)~~ Minuteman missiles are deployed in six wings, each comprising three or four squadrons of 50 missiles. Squadrons consist of five flights of ten silos and one two-man launch control facility. Each Minuteman launch control facility can initiate launching of any missile in the squadron. The launch control facilities and the silos are separated by 5 to 7 n mi at Wing I and by 3 to 5 n mi at all others. Alternate control of Minuteman launching from airborne stations is provided by ALCC and ABNCP aircraft (Fig. 2) via PACCS command-control-communications linkage. About 30 aircraft are involved. One third of these are usually on 15-minute ground alert at several interior airbases.

(U) Each Minuteman wing is serviced at field level by a strategic missile support base that repairs, maintains, and replaces RVs, guidance systems, ground electronics, power/mechanical systems, transportation and handling equipment, and crypto-equipment. For depot level service, boosters go to Hill AFB, Utah, guidance assemblies to Newark AFB, Ohio, and reentry systems to Kelly AFB, Texas.

~~(S)~~ In 1975 the programmed force stabilizes at 54 Titan 2, 450 Minuteman 2, and 550 Minuteman 3. Six of the 450 Minuteman 2 boosters are configured to launch the 494L Emergency Rocket Communications System.



(U) Fig.1—U.S. land-based strategic missile deployment (U)



(C) Fig.2—Minuteman command control netting (U)

DOE 6.2(a)

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Missile	Wing (Operational Date)	No. of ICBMs	SMS	Sqn.	Central Airfield Lat./Long.	N Mi Distance to Moscow	Volgograd	Peking	Target[a] Access (Percent)
MINUTEMAN-2 (LGM-30F)	Ellsworth, S. Dak. 2 SMW 44 (4/73)	50 50 50	66 67 68	4 5 6	44.1/-103.1	4590	5140	5150	100
	Whiteman, Mo. 4 SMW 351 (10/67)	50 50 50	508 509 510	10 11 12	38.7/-93.5	4740	5300	5650	100
	Malmstrom, Mont. 1 SMW 341 (5/69)	50 50 50	19 12 490	1 2 3	47.5/-111.2	4490	5030	4790	100
MINUTEMAN-3 (LGM-30G)	(7/75) MM-3	50	564	20					B3: 64
	Minot, N. Dak. 3 SMW 91 (12/71)	50 50 50	740 741 742	7 8 9	48.4/-101.3	4320	4870	4980	B2: 99 B3: 67
	F. E. Warren, Wyo. 5 SMW 90 (2/75)	50 50 50 50	319 320 321 400	13 14 15 16	41.1/-104.8	4780	5340	5260	B2: 91
	Grand Forks, N. Dak. 6 SMW 321 (3/73) SAFEGUARD[d]	50 50 50	446 447 448	17 18 19	47.9/-97.4	4300	4850	5090	B3: 67
TITAN-2 (LGM-25C)	Davis-Monthan, Ariz. SMW 390 (<1963)	9 9	570 571		32.2/-110.9	5250	5870	5508	91
	McConnell, Kan. SMW 381 (<1963)	9 9	532 533		37.6/-97.3	4730	5380	5620	100
	Little Rock, Ark. SMW 308 (<1963)	9 9	374 377		34.9/-92.2	4780	5440	5880	99

Performance and Payload Data

MINUTEMAN-2

RV = Mk-11C, 830 lb [redacted]
Ballistic coefficient = 1200
CEP: current 2200 ft, projected 1800 ft
NRE[b] range with Mk-11C + Mk-1A ≃ 6700 n mi
Weapon system reliability = .87
Silo hardness about 2000 psi } Severe damage
LCF hardness = 44P6 }
RV radar cross section = .0015 to .06 m^2 at 4300 to 153 Mhz and 0-40° aspect.
[redacted]
Pen-aids Mk-1, Mk-1A: 400 n mi chaff train, nine 35 n mi clouds spaced 50 n mi apart.

Booster Performance Range (n mi)	Payload (lb)
5000	1600
5500	1500
6000	1380
6500	1290
7000	1200

MINUTEMAN-3

Reentry system Mk-12 Mod 3 (MIRV)
RV = [redacted] KT, 350 lb
Ballistic coefficient = 2300
CEP: current 1000 ft, projected 600 ft[c]
Weapon system reliability = .85
Silo hardness about 2000 psi } Severe
LCF hardness = 44P6 } damage
RV radar cross section = .005 to .8 m^2 at 4300 to 153 Mhz and 0-30° aspect.
[redacted]
Chaff clouds are spaced 15 n mi apart.
Max MIRV footprint = 300 × 900 n mi
Post boost vehicle burn time = 440 sec.
ΔV = 1250 fps

MIRV Config.	Chaff Clouds	NRE[b] Range (n mi) 1st RV	2nd RV	3rd RV
A2	0	6030	7760	None
A3	0	5030	5650	6270
B2	16	5570	5620	None
B3	16	4430	4520	4600

Booster Performance Range (n mi)	Payload (lb)
5000	2150
5500	1990
6000	1860
6500	1760

TITAN-2

RV = Mk-6 Mod 3, 7500 lb, [redacted]
Ballistic coefficient = 600
CEP = 4300 ft
NRE[b] range with Mk-6 = 6200 n mi
Weapon system reliability = .8
Silo hardness = 40P6 } Severe damage
LCF hardness = 44P6 }
RV radar cross section = 1.1 to 2.9 m^2 at 4300 to 153 Mhz and 0-40° aspect.
Pen-aids: 6 midcourse decoys or 8 terminal decoys spaced 12 n mi apart. 200 n mi chaff train.

Booster Performance Range (n mi)	Payload (lb)
5000	10300
5500	9300
6000	8700
6500	8000
7000	7400

[a] Rotating-earth access to Soviet ICBMs, IRBMs, MRBMs, bomber bases, bomber staging bases, fighter bases, and major-population centers.

[b] NRE: Non-Rotating Earth.

[c] Supporting Data for Fiscal Year 1976 Budget Estimates. Department of the Air Force, submitted to Congress January 1975 (Secret).

[d] SAFEGUARD (IOC 6/75)
MSR Radar
PAR Radar
30 Spartan
70 Sprint.

Fig. 3 — Summary of the U.S. ICBM force (U)

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~~(S)~~ Table I

ICBM VEHICLE CHARACTERISTICS (U)

Titan 2 (10,650-lb payload)

	Stage-1	Stage-2	Stage-3
Weight, lb	329,187	74,132	
Propellant, lb	243,869	57,902	
Dead weight, lb	11,186	5,580	
Load ratio	.956	.912	
Mass ratio	3.856	4.568	
Burn time, sec	145.6	178.3	
Thrust, vac, lb	474,000	100,000	
Isp, vac, sec	283	308	
Liftoff thrust/wt	1.44	1.35	
Burnout thrust/wt	5.56	6.16	
"Ideal" velocity, fps	12,311	15,073	
Stage ref. area, sq ft	78.5	78.5	
Nozzle exit area, sq ft	20.3	22.4	

Minuteman 2 (1,300-lb payload)

	Stage-1	Stage-2	Stage-3
Weight, lb	72,281	22,062	5,550
Propellant, lb	45,800	13,835	3,660
Dead weight, lb	4,419	2,677	590
Load ratio	.912	.838	.861
Mass ratio	2.730	2.682	2.973
Burn time, sec	55.8	60.0	54.5
Thrust, vac, lb	220,000	66,000	18,500
Isp, vac, sec	268.1	286	275.7
Liftoff thrust/wt	3.04	2.99	3.33
Burnout thrust/wt	8.31	8.02	9.79
"Ideal" velocity, fps	8,673	9,089	9,569
Stage ref. area, sq ft	20.6	16.4	11.8
Nozzle exit area, sq ft	11.5	12.6	5

Minuteman 3[a]

	Stage-1	Stage-2	Stage-3
Weight, lb	75,332	24,144	8,398
Propellant, lb	45,751	13,670	5,614
Dead weight, lb	5,437	2,076	784
Load ratio	.894	.868	.877
Mass ratio	2.547	2.305	3.017
Burn time, sec	60.2	62.2	50.85
Thrust, vac, lb	206,487	62,306	32,900
Isp, vac, sec	271.7	283.5	298
Liftoff thrust/wt	2.741	2.58	3.92
Burnout thrust/wt	6.98	5.95	11.82
"Ideal" velocity, fps	8,183	7,628	10,600
Stage ref. area, sq ft	23.4	14.8	14.8
Nozzle exit area, sq ft	11.4	12.6	10.0

[a]Minuteman 3 Payload

Dry bus	348	Burn time	440 sec (230 at max thrust)
Propellant	257		
Shroud	200	Isp	282 sec
Chaff set	210	Velocity	1,400 fps
3 MIRVs	1,050	Thrust:	
Total	2,065 lb	axial	316 lb
		pitch	22.6 lb
		yaw	22.6 lb
		roll	18.6 lb

CURRENT ICBM FORCE EVOLUTION

(U) The Titan program was initiated in 1955 as an alternate and backup to Atlas (in view of the risks then associated with its pressurized structure) and to stimulate performance advances by tolerating greater technical risks. The resulting Titan 1 was a true two-stage cryogenic-fueled ICBM with a semi-monocoque structure. The Titan 2, initiated in 1959 and declared operational in 1963, featured all-inertial guidance, hypergolic, noncryogenic storable propellants, and launching from the silo. Its payload was greatly increased over Atlas and Titan 1.

(U) The Minuteman program originated in 1958 as a second-generation ICBM, featuring continuously alert solid-fueled missiles in dispersed unmanned silos under centralized control. The Minuteman missile system was declared operational in December 1962. Its subsequent evolution and growth are summarized in Fig. 4 and Table 2.

~~(S)~~ Minuteman 1 evolved as a quick response to the early Soviet ICBM deployments in the late 1950s. Action on Minuteman 2 began in 1961 partly as a response to the Soviet SS-9 ICBM and the Galosh anti-ballistic missile (ABM) developments. In addition to the major improvements summarized in Table 2, Minuteman 2 accommodated a change in firing doctrine from a single "spasm" response to multiple war plans and target sets. The directives for Minuteman 3 implementation in 1966 were partly motivated by the continuing buildup of the Soviet ICBM force and the ABM activities at Leningrad and Sary Shagan. The major improvements included a new third stage for increased throw weight, and MIRV (multiple independently targeted reentry vehicle) payloads in various RV, decoy, and chaff combinations.

CURRENT PROGRAM

~~(S)~~ The Minuteman program funding from FY 1976 to scheduled completion is $318M for RDT&E and $1553M for procurement. The major items are:

- Upgraded silos. Nuclear hardening program to increase silo hardness from about 300 psi to about 2000 psi. Order of effort: Wings 2-5-3-6-1-4. Wings 2 and 5 are completed in 1975, Wing 4 in 1979.

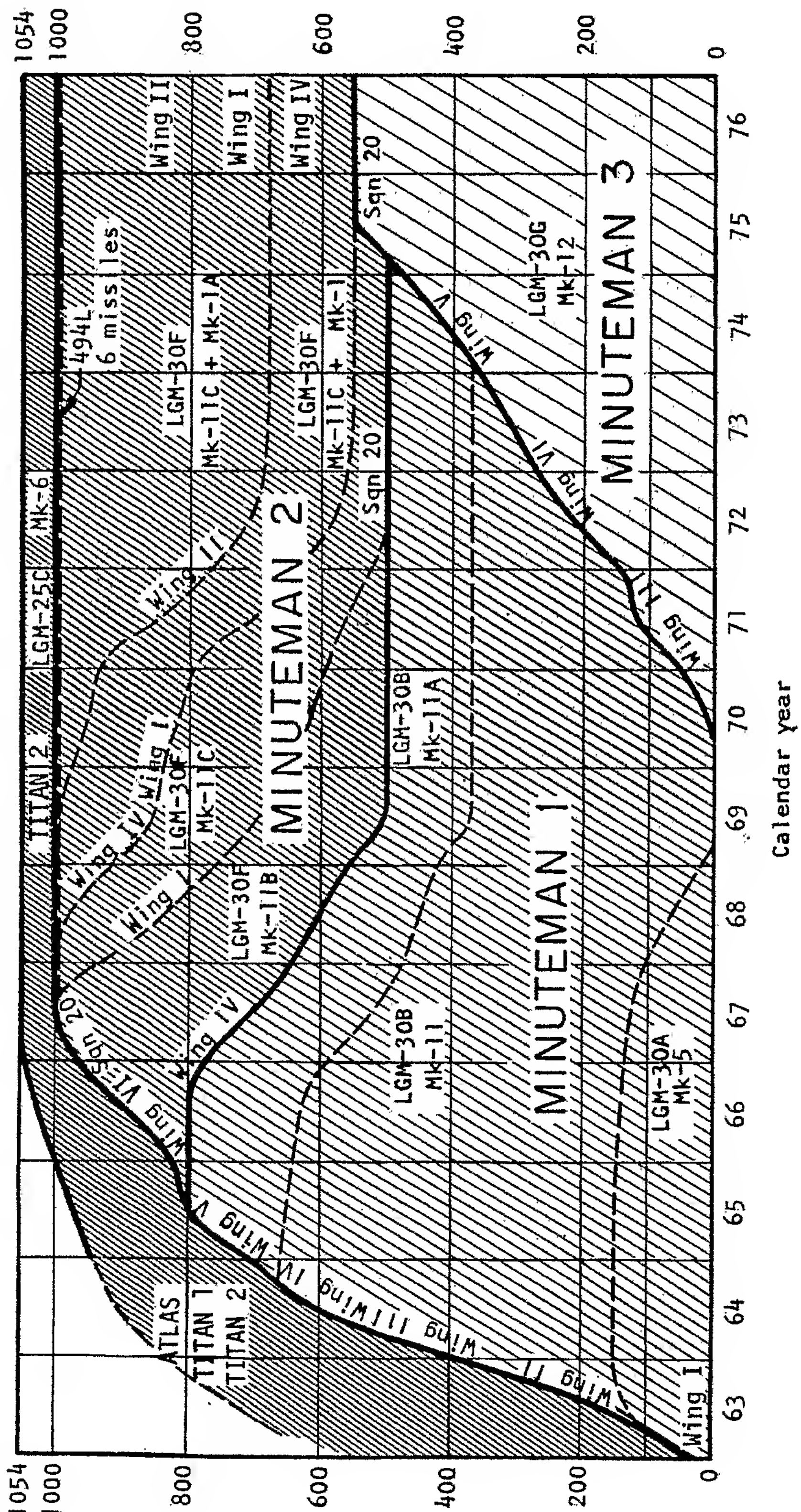


Fig.4—U.S. strategic missile and reentry systems force mix history (U)

~~(SRD)~~ Table 2

MINUTEMAN MAJOR EVOLUTIONARY IMPROVEMENTS (U)

MM-1 LGM-30A (Initial Operational Capability [IOC] 1962)

- Range 5500 n mi
- Mk-5 soft RV
- Yield [redacted]
- CEP 5000 ft
- 100 psi silo; soft support facilities
- Self-power endurance 6 hr (batteries)
- Single target

MM-1 LGM-30B (IOC 1963)

- Mk-11 soft RV → Mk-11A blast hardened in 1965
- Yield [redacted]
- 300 psi silo
- 2 targets

MM-2 LGM-30F (IOC 1965)

- New second stage
- Range 6700 n mi
- Mk-11B EMP (electromagnetic pulse) hardened → Mk-11C X-ray hardened in 1968
- CEP 2800 ft initially → 2200 ft currently
- Mk-1 chaff pen-aids (penetration aids)
- Silos 300 psi initially, at least 1000 psi by 1979
- Hardened support facilities
- Self-power endurance 9 weeks (motor generator)
- 8 targets--selective launch
- All-azimuth launch
- Time-on-target control
- 100 war plan options
- ALCC (Airborne launch-control center)

MM-3 LGM-30G (IOC 1970)

- New third stage
- 3 Mk-12 MIRVs, hardened for blast, EMP, X-rays
- Yield [redacted] projected for Mk-12A RV
- CEP 1400 ft current, 600-800 ft projected
- Chaff, decoys, pen-aids
- 300 psi silos initially, all at least 1000 psi by 1977
- 3 sets of 3 targets
- Command Data Buffer--complete by 1977

DOE 6.2(a)

- Command Data Buffer (CDB). Provides MM-3 retargeting capability at launch control centers. CDB reduces the time needed for an individual target change from 24 hr to 36 min. The time to retarget the MM-3 force is reduced from 45 days to 10 hr. The CDB activity runs concurrently with silo upgrading. The schedule: Wing 5 in 1975, Wing 3 in 1976, Wing 6 and Sqd-20 (Wing 1) in 1977.

  (Silo upgrading and CDB are combined in the Force Modernization Program. With $397M included for FY 76, the funding from FY 76 to completion is $964M.

DOE 6.2(a)

- Minuteman Improved Guidance, and MM Performance Measurement. Funding is $53.1M for FY 76, $116M to completion for RDT&E and procurement on the missile guidance software, leading to estimated future CEPs of 600 to 800 ft for MM-3. An additional $12M in FY 76 and $1.4M in FY 77 conclude a $92M program to assess and predict MM guidance performance on operational test launches.

- Mk-12A reentry vehicle (RV). Funding from FY 76 to completion is $417M including $36.3M for FY 76. Mk-12A advances the yield of Mk-12 from [redacted] The Mk-12/12A production line will be kept open pending a decision to convert more MM-2 to MM-3. Deployment of Mk-12A starts in 1980.

- MM-3 with smaller RVs (PAVE PEPPER).* Funding from FY 76 to completion is $19M including $5.8M in FY 76. The program covers demonstration flight testing of a MIRV assembly with 5 to 7 RVs. Candidates for testing include Poseidon Mk-3 (150 lb), Trident Mk-4 (210 lb) as well as ABRES "Terminal Evader" and ABRES "High Technology Vehicle" both in the 200-lb class.

- MaRV for MM-3, Poseidon, and Trident-I.* Funding is $21.3M in FY 76 and $46.2M in FY 77 in a continuing program to develop [redacted] terminally guided, accurately delivered Maneuvering RV designed as a hedge against possible future Soviet ABM.

- Reentry environment.* Funding is $55.1M in FY 76 and $70.2M in FY 77 in a continuing program of RDT&E on systems to protect RVs against erosion and deflection due to rain, ice, and snow during descent through the atmosphere.

(S) The Minuteman program cost exclusive of operation, maintenance, and military construction is summarized in the following table.

---

*(S) These items are funded separately from Minuteman as a part of the Advanced Ballistic Reentry Systems (ABRES) program. Ongoing spending rate for ABRES is about $100M per year.

		FY 75 & Prior ($M)	FY 76 ($M)	77T+77 ($M)	To Completion ($M)	Total ($M)
MM-2 MM-3	RDT&E	3,464	123	172	23	3,782
	Procurement	6,725	657	418	478	8,278
	Total	10,189	780	590	501	12,060
MM-1						6,800
All missiles						18,860

(~~S~~) The total MM-2 missile procurement is 668, including 49 for RDT&E and 170 for operational training and spares. The total for MM-3 is 798 including 44 for RDT&E and 204 for operational training and spares. The average cost per UE-MM-3 missile is about $6.5M procured and about $11.5M deployed. Planned production of MM-3 terminates in 1976 but funding is projected to hold the booster production line open pending a decision to convert additional MM-2s to MM-3s.

II. CURRENT ISSUES

Some important public arguments about national security and strategic nuclear forces currently focus on the U.S. ICBM force. The outcomes should be expected to shape the ICBM force that emerges in the 1980s. While the public debate often poses broad questions--Do we need ICBMs? Are ICBMs obsolete?--the answers are being sought by examining specific issues, such as ICBM force survivability, counterforce capabilities, and stability. It may be a matter of judgment whether these individual issues will dominate the larger arguments, but the collective outcomes of these skirmishes may well circumscribe the future of the U.S. ICBM force.

Our discussion of current issues does not attempt to answer the larger questions per se. Those answers evolve from summary judgments about the specific issues. Both the issues and the judgments may change with people and time. The issues we address here are current undecided issues that we believe to be important as well as controversial. Past issues resolved by events, such as MIRVing or ABM defenses, are omitted because their significance is historical; and we assume a familiarity with that history.

For each issue, we outline the principal arguments on each side. Where we can discern how well the arguments are joined, we offer some observations that may be absent from the present debates. In a few cases, we take pains to explain an issue because it is not widely discussed in the open literature, such as the effects of "dust and fratricide" in multiple weapon attacks. We divide our review of current issues into three parts. The first deals with the several aspects of ICBM *survivability*; the second with the *capabilities* of ICBMs to execute strategic tasks; and the third with the *perceived qualities or properties* of ICBM forces.

SURVIVABILITIES

The survivability of the ICBM force is probably the most widely expressed concern about its future and the basis for most arguments

favoring curtailment or rebasing. This concern is focused almost exclusively upon its survival in a surprise disarming attack. This narrow focus has its origins in the "assured destruction" calculus, wherein forces are tested and compared simply for their cost-effectiveness in *countervalue* retaliation after absorbing a maximum Soviet surprise *counterforce* attack.

While survivability in an all-out Soviet attack is a vital concern and a useful comparative test of strategic postures, it is by no means a sufficient basis for assessing the survival problems or prospects of the ICBM force. The significance and likelihood of less extreme attack threats is now recognized. Perhaps even more important, estimates of a single force element's survival of an attack--taken outside the context of the total strategic posture--are now less accepted as an overriding criterion of force effectiveness.

Following are discussions of the prelaunch, in-flight, and enduring post-attack survivabilities for the currently configured U.S. ICBM force under both the present and potential future Soviet threats. (The options for improving the survivability of the ICBM force are deferred until Sec. III.)

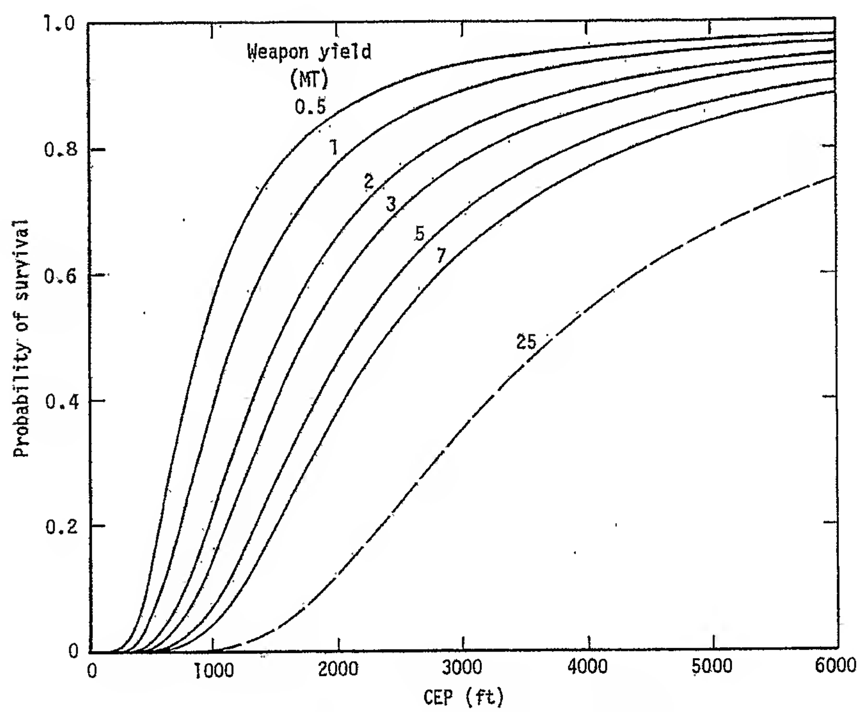
Prelaunch Survivability

The prelaunch survivability of the ICBM force is characteristically measured by the estimated vulnerabilities of the silos to Soviet attacks. These estimates have been challenged as to the technical feasibility of the postulated attacks (because of disagreements over the threat and the parameters that affect ICBM survivability) and the uncertainties inherent in planning and executing a disarming counterforce attack.

There is no wide agreement as to the fundamentals of an effective attack on the ICBM force, such as weapon selection, employment tactics, or kill mechanics. For example, one potentially effective scheme would involve attacks in multiple *waves*, with bomb damage assessment between waves. But any confidence in the efficiency of multiple wave attacks is weakened by the prospect of retaliatory ICBM launches subsequent to the first attack wave. Attacking the entire U.S. ICBM force in a single wave has been challenged as not credible because of attack timing or coordination requirements imposed by such weapon-produced effects as dust and fratricide.

(U) Apart from the attack scheme, variations in the parameters used to describe either the counterforce threat or the U.S. ICBM force can produce substantial differences in the perceptions of CF threat credibility. The most serious threats to the survivability of ICBMs are derived from projections of future Soviet capabilities; these projections vary widely because of implicit assumptions about Soviet technologies, policies, and even international negotiations. Both the quantities and qualities projected for Soviet strategic weaponry have been controverted. While the SALT agreements have placed limits on ICBM quantities, possible compensatory improvements in the threat qualities may leave the general level of uncertainty unchanged.

~~(S)~~ The mathematical relationships between the probability of survival of a hard point target and the yield and delivery accuracy of an attacking weapon are well known. The dominant variable--in view of the uncertainties--is delivery accuracy. Figure 5 shows the probability of survival from a single shot of a 2000-psi hard target as a function of CEP for several weapon yields. The hardening approximates that



(U) Fig.5—Single-shot probability of survival of a 2000-psi target

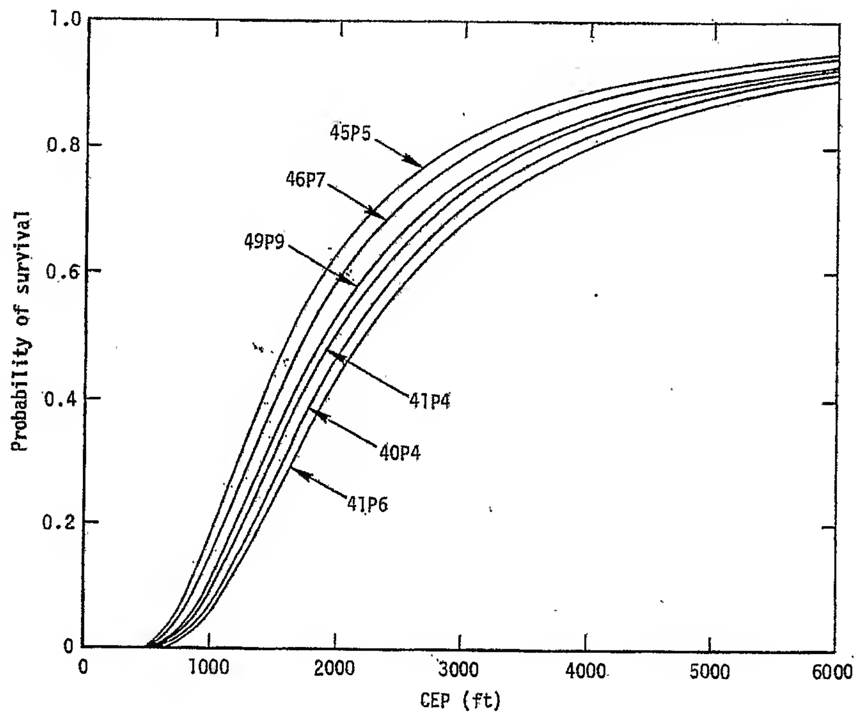
currently associated with "severe" damage to upgraded Minuteman silos, and the range of weapon yields is representative of what might be carried by current and follow-on Soviet ICBMs. While the heaviest Soviet ICBMs are estimated to be capable of carrying a *single* RV of 18 to 25 MT, their numbers permitted under the SALT interim agreements are not sufficient for an attack upon even a third of the U.S. ICBM force.

(S) Current Soviet ICBM accuracies have been variously estimated in the range from 6,000 ft down to 1,500 ft. CEPs as low as 600 ft have been projected for the Soviet ICBMs now being deployed. These estimates, applied to Fig. 5, indicate that Soviet CEPs are likely to be much more important than weapon yields in affecting the calculated prelaunch survival of the U.S. ICBM force in a one-on-one attack.

(U) The assumptions about the vulnerability of the ICBM force are probably open to some well-justified skepticism, particularly as they have been used in the simple force survivability calculations. The weapon effects, the damage mechanisms, and the failure modes for the current ICBM force basing are not sufficiently well understood or confirmed to have been treated so glibly by either side of the ICBM vulnerability debate.

(S) The physical vulnerability of the ICBM force to nuclear weapons is inherently uncertain because of the complexities of the systems and phenomena involved. While there will probably always remain some residual uncertainty in vulnerability estimates, it is generally accepted that the silos, their contents, and the launch control facilities are reasonably balanced in their design for survival against direct nuclear attacks. With the hardness upgrading of the Minuteman facilities, the key vulnerabilities are currently thought to be associated with the missile rattle space and launch alignment--not the hardness of the silos themselves. Although the vulnerability of the ICBM force could be greater than expected because of some unobserved deficiency or weakness, it also could turn out to be less than expected through the cumulative effect of conservative design. Unless the physical vulnerability of the force has been grossly misjudged, the precision of the vulnerability estimates should not drive the prelaunch survivability calculations.

~~(S)~~ Figure 6 illustrates the probability of a Minuteman silo's survival in a 3-MT weapon attack as a function of CEP for several vulnerability numbers which have been associated with the upgraded Minuteman. These vulnerability numbers reflect different estimates made at different times and refer to damage levels from "light" to "severe." It is apparent from Figs. 5 and 6 that the spread in results across all of these vulnerability estimates is substantially less than that due to the uncertainties in Soviet weapon CEPs or yields.



(U) Fig.6—Single-shot probability of survival: Effect of vulnerability number estimates with weapon yield, 3 MT

(U) Even if these basic parameters--delivery CEP, weapon yield, and target vulnerability--could be determined with high confidence, the survivability by the ICBM force of a Soviet attack involves several additional questions. One question is the Soviet capability to compensate for missiles which fail at launch or during flight. The

reprogramming* of additional missiles for boost phase unreliabilities is technically feasible, given provisions for the detection of boost failures and for rapid retargeting. Postboost and terminal unreliabilities are generally thought not to be reprogrammable. The problems of coordinating missiles reprogrammed to compensate for boost failures into a single attack wave are believed to be other than trivial.

(U) Another question is how many weapons might be targeted against each ICBM silo in an attack. Until recently, typical survivability analyses for the U.S. ICBM force assumed that the number of weapons usable is limited only by Soviet resources (throw weight) and technology (multiple vehicles and high yield efficiencies). As a consequence, it was not uncommon for the analyses to assume that the Soviet missiles were highly MIRVed and that the attack on each U.S. ICBM silo involved two, three, or more RVs. Such assumptions have now come under criticism as being inconsistent with the limitations of weapon interactions (dust and fratricide) in mounting an actual large-scale attack upon arrays of hard point targets.

(~~S~~) The importance of the issue is illustrated in Fig. 7. For current Soviet CEPs estimated at between 1,500 and 6,000 ft, the differences in force survival among one, two, or three weapons per silo are substantial. With the yield and CEP combinations projected for future Soviet ICBMs, the differences between one and several weapons per silo could be decisive in a counterforce attack--the difference between tens or hundreds of surviving silos.

(~~S~~) In sum, the prelaunch survivability of the ICBM force--as estimated by the classical analyses of a direct counterforce attack upon the silos--is dominated by the assessment of Soviet CEPs. The hardness of the U.S. silos and the yields and numbers of Soviet weapons become relatively unimportant if Soviet CEPs eventually come to be assessed in the region of 1,000 ft or less. The next most important parameter is the number of RVs that can be effectively used to attack

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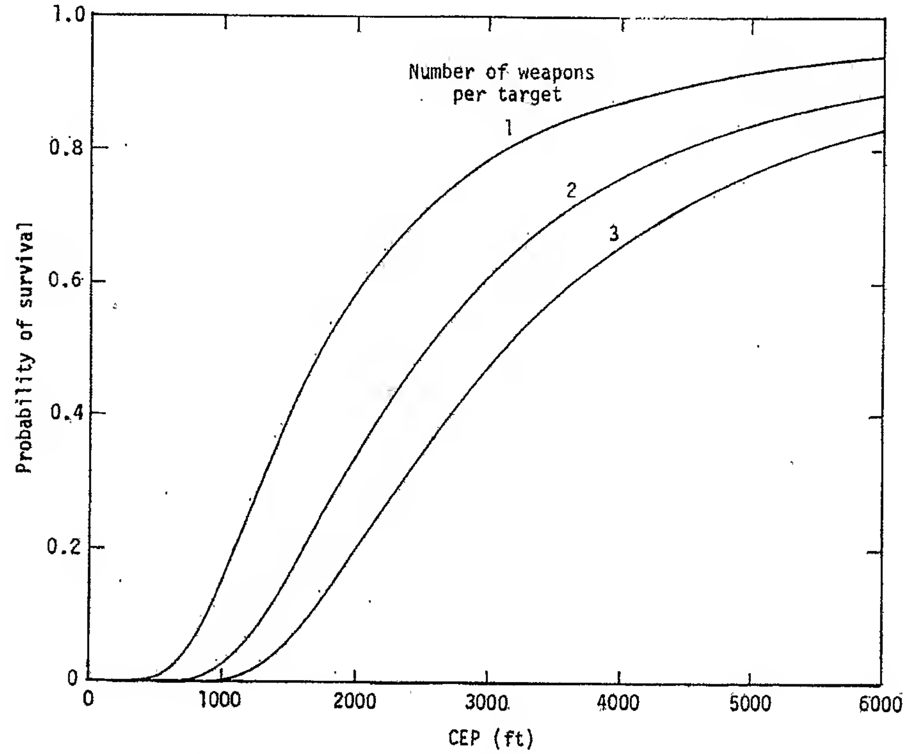
*(U) Reprogramming denotes the launch of backup missiles against aimpoints targeted by failed missiles, generally requiring a capability to rapidly insert target data and compute guidance parameters for the reserve missiles.



(U) Fig. 7--Probability of survival: effect of multiple shots (2000-psi target; 3-MT weapon yield)

each silo. The arguments about that number are now focused on the constraints that may be imposed upon weapon effects.

(U) Dust and Fratricide. There is some argument about the technical feasibility of attacks upon the ICBM force using large numbers of closely spaced RVs because of "dust and fratricide," i.e., nuclear weapons' mutual interference effects. The question is how many RVs can be effectively targeted on each ICBM silo in a *single* attack that would be sufficiently compressed in time as to deny any intervening opportunity to launch the force. Assuming no shortage of attack RVs, the answer appears to depend upon (a) the time-of-arrival "window" for RVs that will avoid serious mutual interference effects, and (b) the means for controlling the attacking missiles within the time and geometrical constraints imposed.

(~~C~~) The weapon interference effects of concern are (a) nuclear radiation, where the prompt neutron effects on nuclear materials could cause weapon failure, (b) shock waves, where the blast and wind loads

upon the RV could cause impact dispersions or structural failures, and (S) dust and debris, where erosion of the RV heat shield could also cause dispersions or structural failure. These effects can result from multiple detonations at the same or adjacent targets.

(S) In general, weapons aimed at the same target define the minimum weapon spacing and, hence, a lower bound on the time-of-arrival window because of the potential for fratricide due to shock waves or radiation. This lower bound on weapon time separation is typically 3 to 5 sec, depending upon the RV velocity, which, in turn, depends upon whether the RV has a high or low aerodynamic loading (beta). The upper bound on the window is defined by shock waves from weapons at adjacent targets which could cause dispersions of the incoming RV and is about 10 to 18 sec, depending upon the spacing between adjacent targets (typically 3 to 5 mi in the Minuteman deployments). Even though the time-of-arrival window thus defined is bounded by short-term effects (radiation and shock waves), further windows are believed by some to be closed by dust clouds and falling debris for as long as 30 to 60 min.

(S) If only one RV is targeted on each silo, all adjacent weapons would have to arrive within a span of 10 to 18 sec to avoid interference effects. While this degree of attack control is generally believed to be technically feasible, backup reprogramming missiles after boost failures within this time window appears to be a significant challenge: To reprogram after late failures in the boost phase, the reprogrammed missiles may be launch-delayed by as much as six minutes with respect to the programmed attack, and this difference would have to be recovered in the flight times of the backup missiles. A combination of means has been proposed for this control of flight times: (a) launching the attack from the longest-range sites and reprogramming backup missiles from shorter-range sites, and (b) launching the attack on lofted trajectories and reprogramming backups with depressed trajectories. The arguments about these possibilities are not so much about their technical feasibility as their credibility for an actual attack.

(S) If *two* RVs are targeted at the same silo, the weapons would have to be separated by at least 3 to 5 sec, and yet all pairs arrive

within the same 10 to 18 sec at all adjacent silos. The number of arriving weapons to be coordinated within the narrower time constraints has doubled, and the uncertainties in attack timing and weapon effects (e.g., stem size) are seen as being significant when compared to the attacker's timing tolerances and risks. Hence, there remains some argument as to the technical feasibility and credibility of a single-wave coordinated attack using two *surface* bursts on each silo.

(S) Several alternative attack schemes have been suggested as a means for avoiding interaction effects with two RVs targeted on each silo. One is to ignore the minimum spacing required between weapons and use the second weapon as a simple backup should the first RV fail either to arrive or to detonate. Since this approach would compensate only for the weapon system's unreliability and not for the random aiming errors, it may not be an efficient use of attack resources. It could, however, eliminate many of the complexities of reprogramming the attack; and some would argue that the Soviets need not be concerned that the use of their larger throw weight be efficient.

(S) Another approach would be to minimize the dust and debris by programming the first RV to airburst; this would be followed by a ground burst of the second RV. The timing window might be widened by as much as five minutes in the period otherwise considered closed by early dust and debris effects. This would require airburst fuzing and probably some hardening of the RVs against the airburst effects. Moreover, the airburst may not be as effective against the silos as a ground burst, and the fuzing might be countermeasured.

(S) Still other tactics include delayed detonation of the weapons (earth penetrating mines that could be simultaneously triggered) and offset aimpoints that would separate the arriving weapons in *space* (straddling the target) rather than separating their time of arrival at the target. These demand sacrifices in RV weight or effectiveness, and they appear to be not so much serious proposals as speculative possibilities for a resourceful and determined attacker.

(S) It is now generally accepted that three RVs on the same silo cannot pass through the 10- to 18-sec time-of-arrival window with any credible margin for error and still avoid serious interaction effects.

(S) The "dust and fratricide" arguments, while focused on weapon interference effects (and attack schemes to circumvent those effects), may epitomize more basic arguments over the use of simplified force exchange calculations to determine ICBM force survivability. Many calculations of the *future* survivability of the *current* Minuteman have assumed force-wide attacks by multiple RVs on each silo, while ignoring specific consideration of timing requirements or weapon interference effects. Those calculations have been challenged as erroneous over-simplifications of important realities in actual attack planning, *exemplified* by the dust and fratricide considerations. These realities cannot be neglected, it is argued, because their accommodation will exact heavy tolls in attack resources or effectiveness, neither of which can be wasted for credible first strikes against the U.S. ICBM force.

(S) An opposing view is that the simplified calculations are not necessarily invalid because they lack such detail, that there are types of attack that can be adequately represented by the simplified calculations. Even though weapon interference effects are an important aspect in an actual attack, this "opposing" view does not accept that our knowledge is sufficient to *exclude* the possibility of multiple RV attacks on our silos.

(S) In any event, these arguments have raised doubts about the efficacy of highly MIRVed missile attacks upon the U.S. ICBM force. If single-wave attacks of more than one or two RVs per silo are discounted because of weapon interference effects, then the estimated survival of the ICBM force will be less sensitive to increased MIRVing and even more dependent on the delivery accuracy of Soviet RVs.

(S) Launch on Attack Assessment. Even if all of the *technical* uncertainties attending prelaunch survivability were resolved, other inherent uncertainties in military and political planning for large-scale counterforce attacks are likely to remain an issue. In addition to the technical uncertainties, the attacker's risks of being preempted (or having the ICBM force launched before the attack is completed) are unquantifiable. One view is that such risks make a deliberate, carefully planned attack incredible; an opposing view holds that such risks are irrelevant in classical deterrence calculations, which are concerned with possibilities more than probabilities.

(U) The mere possibility of the U.S. ICBMs' being launched upon confirmation of a Soviet ICBM attack, even if launch-on-attack assessment is not explicitly adopted as policy, is held by some to pose an intolerable risk in any Soviet contemplation of an effective surprise attack upon the U.S. ICBM force. Even if the Soviets had high confidence in the silo kill capabilities of their ICBM force, it is argued that they could not be sure that their attack would be successful because "the Russians would have to consider that Minuteman might be launched against Russian targets in the 30-min warning time between the launch of the Russian ICBMs and their arrival at the Minuteman silos."[*]

(U) There are two important aspects to the credibility of this potential capability as a deterrent to the Soviets. One is how the Soviets might judge prospective U.S. actions in the light of our policy statements. The President has rejected "sole reliance on a 'launch-on-warning' strategy" because it "would force us to live at the edge of a precipice and deny us the flexibility we wish to preserve."[†] Whether the Soviets might interpret such policy statements as defining our intentions or not is unclear and can be argued either way.

~~(S)~~ The other aspect is whether the current U.S. ICBM force could, in fact, be launched on attack assessment. There is little doubt that the ICBM force can be postured to launch upon almost any arbitrarily small time of notice. But that is not the same as saying that the current capabilities for attack assessment, launch procedures, command, control, and communication (C^3) links--including the national command authority--are all *routinely* compatible with launching the force out from under an incoming attack. If there are weaknesses in our present capabilities, they may be known to the Soviets, who, consequently, may not be deterred. If, in a crisis, we could pose a credible threat of launching ICBMs immediately upon warning, then the classical scenario of a carefully sprung Soviet attack would be invalid. But to ready all ICBMs and keep them ready indefinitely has been contested as inconsistent with national policy.

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[*](U) Barry Carter, "Nuclear Strategy and Nuclear Weapons," *Scientific American*, Vol. 230, No. 5, May 1974.

[†](U) Richard Nixon, "U.S. Foreign Policy for the 1970s--The Emerging Structure of Peace," *A Report to the Congress*, February 9, 1972.

(S) If launching the U.S. ICBM force upon assessment of a Soviet ICBM attack is accepted as being credible to the Soviets, the *conceptual* possibilities for an effective surprise attack are not exhausted. Soviet SLBM attacks upon the U.S. ICBM force would severely compress--if not deny--the time for attack assessment and launching of the force; but the hard target kill capabilities of the Soviet SLBM force are not perceived to be adequate for an effective silo attack in the foreseeable future. A more imaginative use of the Soviet SLBM force against ICBMs would be to maintain exo-atmospheric nuclear bursts over U.S. ICBM sites temporarily, until the arrival of the silo-killer ICBMs. This SLBM "pindown" scheme would be designed to expose the U.S. ICBM force to *in-flight* attack if it were launched before the arrival of ICBMs.

In-Flight Survivability

(U) In the absence of significant ABM deployments, there are few concerns about the in-flight survivability of ICBMs. The most frequently discussed involve the following possibilities: (1) interactions with U.S. defenses, (2) "pindown" attacks, (3) "exotic" ABM concepts, (4) interaction of RVs with extreme but natural environmental conditions, and (5) fratricide by earlier-arrived weapons. The first of these, the interaction between U.S. ICBMs and ABM defenses (SAFEGUARD or site defense) would be of concern only if U.S. ABM deployments were greatly expanded. The current directions in arms control negotiations are leading instead toward *more stringent* limitations on ABM deployment.

(U) The Soviet SLBM (submarine-launched ballistic missile) force is large enough to raise the possibility that SLBMs might be detonated at high altitude over ICBM launch areas to subject the ICBMs to boost phase damage. It has been observed that the ICBMs are relatively vulnerable while boosting and MIRVing and that SLBM launchers could be located in advantageous positions to attempt the attack. The credibility of this tactic has been challenged on the grounds that the timing and execution are both technically and operationally difficult, and that it would require committing too many SLBMs and nuclear-powered ballistic-missile submarines (SSBNs) in a venture of great risk and uncertainty. How seriously the pindown threat might be viewed in the

future is problematical. Improvements in the qualities and numbers of SLBMs suggest the threat could be worse. But ASW surveillance, improvements in ICBM hardness, better attack assessment sensors (to find safe launch windows), and the possibility of new basing modes for ICBMs, all suggest that pindown attacks will not be a serious problem.

~~(S)~~ Concerns are sometimes expressed about the vulnerability of ballistic missiles to long-range lasers or electron beam weapons. While numerous concepts for these exotic weapons or their employment have been studied, so far they are thought to be either technically infeasible or too costly. The potential laser threat has resulted in modest programs to balance better the hardening of the missiles. The threat of exotic weapons is not unique to ICBMs and has not figured importantly in any of the recent debates over the U.S. ICBM force.

~~(S)~~ Abnormal environmental conditions can produce water, ice, and dust in the atmosphere that could accelerate the erosion of the RVs to the point of introducing large dispersions or even destroying them. The problem is most severe for RVs having a high aerodynamic loading. One concern is that large geographical areas (containing targets) may be temporarily protected by passing storm systems that interfere with reentry. The resolution of the present uncertainties will depend upon current efforts to assess weather in the target areas and to ensure that RVs will withstand adverse weather conditions.

~~(S)~~ The environmental hazards for RVs caused by the detonations of weapons upon closely spaced targets are more severe than those expected from natural phenomena. As was described earlier, the dust and fratricide effects can be mitigated by careful control of the attack timing, at least for one, and perhaps two, weapons per aim point.

<u>Postattack and Enduring Survivabilities</u>

(U) The importance of long-term, or enduring, survivability for postattack withholding of the ICBM force—or any of the strategic nuclear forces—is not universally accepted. One viewpoint is that the survivability and availability of the ICBM force for more than a few hours after any major attack upon the U.S. is irrelevant because (a) the ICBM force would be launched within that time period, and (b) there

would be other, more important concerns for national survival in that event. The opposite viewpoint is that the enduring survivability and availability of the ICBM force is more important than the initial survival in an attack because of (a) the way nuclear conflicts are likely to develop, and (b) the political significance of being able to withhold and retain viable strategic forces in a postattack environment.

(~~S~~) The immediate postattack availability of undamaged elements of the U.S. ICBM force does not appear to be at issue. The force routinely operates on commercial power with diesel-electric generators providing primary backup. Temporary emergency power is available from batteries. The batteries are located within the missile silos and are adequate for missile launch operations if executed within a few hours after the loss of commercial power or diesel-electric backup. (The upgrading of the Minuteman silos increases the battery capacity from 6 to 20 hr.)

(~~S~~) For longer periods, the launch availability of the ICBM force in a severely degraded postattack environment is problematical. First, there is some uncertainty as to the survivability of the backup diesel-electric generators. For the Titan, these generators are within the silos, but fuel for much more than three days is not. For the Minuteman, the generators are all outside the silos, variously protected (they are underground but soft for Wings I and II, hardened to 25 psi for Wings III, IV, and V, and to 300 psi for Wing VI).

(~~S~~) Second, there have been reliability problems both in starting the backup generators and in switching from generator to battery power. In spite of the good reputation of diesel-electric equipment for high reliability, this subsystem has been one of the most troublesome in the Minuteman system.

(~~S~~) Third, there is some concern about the ability to carry out essential maintenance activities in severe postattack environments. While noncritical maintenance is indicated and performed frequently, critical maintenance to restore the launch capability of a Minuteman silo is required, on the average, about once every 6 or 7 weeks. (Most of the critical maintenance for Minuteman is in subsystems other than guidance; the mean time between failures (MTBF) for guidance systems is on the order of 5 to 6 months.)

(~~S~~) The direct effects of a large-scale attack are likely to include the destruction or damage of substantial quantities of maintenance resources; and the indirect effects (e.g., fallout and transportation damage) might delay access to the silos. The tunnel access to the Titan silos from the launch control facility overcomes part of the problem, as long as the required maintenance tasks are within the resources of the launch crew.

(~~S~~) The extent of these concerns for the enduring availability of the ICBM force is illustrated by the following exemplary calculation: An attack by 1,000 reliable RVs, each having a yield of 1.2 MT and a CEP of 3,500 ft, upon the Minuteman force is estimated to leave about 840 silos surviving. On battery power, these 840 would remain operable for less than a day. The same attack is estimated to destroy all but about 165 diesel-electric generators as a *collateral* effect. If 75 percent of the surviving generators are successfully started and switched over to supply power, about 125 silos would remain operable after the first day following the attack. If the MTBF for critical maintenance is taken at 40 days, the number of alert missiles would drop below 100 within ten days, and below 60 within a month. While the numbers are arguable, the calculation does indicate that attacks incapable of destroying more than a modest fraction of the ICBM force might severely jeopardize the enduring availability of the force.

(U) Finally, the enduring survivability of the ICBM force could be circumscribed by the vulnerability of the current basing structure to follow-up bomber attacks. Since bomber attacks would require hours to execute--and probably would be preceded by considerable warning--this threat is viewed as being principally against withheld ICBMs and, hence, a concern for their enduring survival. The credibility of such follow-up bomber attacks on the ICBM force is seen by some as being enhanced by (a) the paucity of air defenses to protect the U.S. ICBM force and (b) the potential efficiency of bomber attacks in the absence of opposing air defenses.

(U) A demurring view is that air defenses to "preclude bomber attacks on withheld ICBMs...might still have some advantage today." But if the Soviets deploy their "new MIRVed ICBMs up to the limits

allowed by the Interim Agreement..., the USSR would have enough ICBM RVs to launch a series of follow-up attacks against our withheld ICBMs." Thus "we would need a balanced defense against both missiles and bombers. Such a defense is foreclosed by the ABM Treaty."*

CAPABILITIES

The capabilities of the ICBM force have been issues in several important arguments. Some of these arguments, while apparently centered on the ICBM, really reflect some basic differences in perceptions of the purposes and uses of strategic forces. The answers to the central questions of what we want of our strategic posture and what we expect our strategic forces to be capable of doing under various circumstances are, of course, vital to any assessment of the capabilities and qualities of the ICBM force. But this is not the place to elaborate upon the broader questions of strategic posture planning objectives or criteria; they are worthy of separate attention.

In past public discussions, the capabilities of our strategic offensive forces have been typically appraised quite narrowly, as applied just to countervalue tasks (e.g., assured destruction); such an appraisal generates a simple criterion for comparing the relative cost and effectiveness of "competing" force elements. While other tasks, especially counterforce tasks, have long been recognized within the military planning community, they are not yet widely accepted in public discussions as a basis for strategic-force planning. It is apparent that the new directions for U.S. strategic nuclear policy as proposed by the Secretary of Defense are toward a broader interpretation of the strategic tasks to be considered. Thus, even in the public discussions, the capabilities of strategic forces may be appraised more broadly than they have been, to include counterforce tasks and limited strategic operations--tasks still to be fully defined or widely embraced.

But even within this broadened interpretation of the strategic tasks, there remains the important question of whether the ICBM

*Quotations from the Report of the Secretary of Defense, James R. Schlesinger, to the Congress on the FY 1975 Defense Budget and FY 1975-1979 Defense Program, dated March 4, 1974.

force--or any one of the three strategic offensive force elements that compose the Triad--enjoys a unique role in the strategic posture. The answer depends upon the scope of the synergism ascribed to the Triad: while the elements of the Triad are recognized as being mutually supportive in their *survivability* against attack, are they also to be mutually supportive in their diverse capabilities to *execute* strategic tasks?

Here, it is sufficient to refer to three broad strategic tasks that encompass those objectives and roles most frequently cited. We shall deliberately not develop the major arguments that support the contributions of these strategic tasks to national security or their implications for the strategic posture. The three strategic tasks are:

1. Countervalue (CV): *Major* strikes against a broad spectrum of civil and military targets.
2. Counterforce (CF): *Major* strikes against selected strategic force targets.
3. Limited strategic operations (LSOs): High-confidence, limited, and closely controlled strikes against selected civil or military targets.

Countervalue

Excepting their survivability, the capabilities of ICBMs for countervalue tasks are generally admitted. In the absence of major ABM deployments--as presently prescribed by the SALT agreements--there is virtually no doubt that ICBMs can execute countervalue strikes, provided enough survive until a decision is made to launch them. In such characteristics as weapon yields, accuracy, response times, positive control, and reliability, the capabilities of ICBMs are generally more than adequate for the modest technical demands of countervalue tasks.

Survivability has been addressed from at least three directions. One is to forget about it by releasing the ICBMs--in our planning--from any major contribution to countervalue tasks. Another is to seek the means for improving the survivability of the ICBMs, as by rebasing the force. And a third approach is to consider how a small number of

surviving ICBMs might be made more effective for countervalue tasks, via such improvements as increasing the throw weight and number of RVs per missile.

Counterforce

The counterforce capability of the U.S. ICBM force is one of the most controversial issues in national security policy and planning today. Because counterforce is almost always considered in the context of a classical missile duel, in which the ICBM forces of the two opponents are pitted against each other in an isolated series of exchanges, counterforce tasks have devolved to silo busting; hence, the counterforce capabilities of ICBMs have become synonymous with hard-target kill capabilities; and in the words of the Secretary of Defense, "Any discussion of hard-target kill capability inevitably arouses controversy...."*

In a broader sense, if counterforce tasks are taken to include strikes against the full array of strategic-force-related targets--encompassing airbases, submarine ports, C^3 and defense sites--then the counterforce potentials of ICBMs include much more than hard-target kill capability. Against many of these relatively soft targets, the yield and the accuracy of U.S. ICBMs are more than adequate. Against some, such as the submarines in port or the C^3 and defense sites, the short delivery times of ICBMs preclude protective reactions. Thus, the counterforce capabilities of the U.S. ICBM force for quick and confident delivery of nuclear weapons are significant, quite apart from the ability to kill hard targets.

Nevertheless, the public discussion of counterforce is likely to remain more narrowly oriented within the context of missile exchanges. The SALT agreements have the effect of inviting comparison of similar forces; and silo-based ICBMs are unique among strategic forces in that they are the principal threat to their counterparts. Thus, the counterforce capabilities of the U.S. ICBM force are certain to be compared with the Soviet ICBM force both in fact and in appearance.

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*Report of Secretary of Defense James R. Schlesinger to the Congress on the FY 1976 and Transition Budgets, FY 1977 Authorization Request and FY 1976-1980 Defense Programs, February 5, 1975.

(U) The factual aspects of concern are the relative survivabilities and hard-target kill capabilities of the opposing ICBM forces. The hard-target kill capabilities of the *current* U.S. ICBM force are modest; we could not expect to kill even one Soviet silo for each U.S. reliable missile fired. As shown in Table 3 for representative hardened targets, the accuracy and weapon yield combinations for current ICBMs do not provide high damage probabilities unless multiple RVs are employed against each target. (However, see above, under "Dust and Fratricide.") The *current* Soviet ICBM force has the same problem despite significant differences in the two forces.

(S/FRD) Table 3

DAMAGE PROBABILITIES FOR RELIABLE ICBMs AGAINST REPRESENTATIVE HARD TARGETS (U)

Target Vulnerability Number	Minuteman 2	Minuteman 3	Titan 2
	DOE 6.2(a)		
	2200 ft CEP	1000 ft CEP	4300 ft CEP
33P2 (Some weapon storage sites)	.58	.65 (1 RV) .88 (2) .96 (3)	.58
37P6 (SS-9 silos)	.49	.55 .80 .91	.55
48P6 (New ICBM silos)	.16	.18 .33 .46	.18
51P6 (Some weapon storage sites and control centers)	.11	.12 .22 .32	.13

(U) The technical feasibility of developing hard-target kill capabilities in ICBMs has never been seriously questioned since their first operational deployments. While there may be some confusion about hard-target kill capabilities in U.S. and Soviet ICBMs, the

central issue is the *future* development of these capabilities, especially by the United States. It is apparent that the controversy surrounding the need for hard-target kill capabilities is durable and its resolution is not in sight.

The future problem is "another contingency about which we must remain concerned. Since both we and the Soviet Union are investing so much of our capability for flexible and controlled responses in our ICBM forces, these forces could become tempting targets, assuming that one or both sides acquire much more substantial hard-target kill capabilities than they currently possess. If one side could remove the other's capability for flexible and controlled responses, he might find ways of exercising coercion and extracting concessions without triggering the final holocaust."*

Even if this future problem should not materialize in fact, it is currently arising in appearances--as the opposing ICBM forces are compared on measures that are easily or widely appreciated--numbers of missiles, throw weights, and the numbers of RVs per missile. It is on these measures--and not on the more esoteric (and relevant to counterforce) parameters--that much of the public and political comparison is made. Under the terms of the Vladivostok Agreement and given the asymmetries between the U.S. and Soviet predilections in strategic force postures, one would not expect the two opposing ICBM forces to compare closely in appearance. But the problem is not one of small differences; it is that the "throw weight of the Soviet ICBMs will continue to exceed that of the U.S. Minuteman force by a very substantial amount--perhaps by as much as a factor of six (unless the United States also increases its ICBM throw weight)."* The significance of this large disparity in appearances is not clear, but permitting it to remain unchallenged has been opposed on the principles of "essential equivalence," as perceived by both superpower and nonsuperpower nations.

The principal dissenting view is that matching the Soviets by developing counterforce capabilities (i.e., hard-target kill capabilities)

*Ibid.

leads to undesirable instabilities in which each side perceives an advantage in attacking first. The root cause of the concern is seen as the *vulnerabilities* of present land-based ICBMs to their opposing counterparts. It is argued that if vulnerabilities are removed--by rebasing the ICBM force or by eliminating it--then the development of Soviet hard-target kill capabilities will be of no particular significance. As to the capability for flexible and controlled responses now being invested in our ICBM forces, it is held to be either unnecessary or better invested in more survivable forces.

(U) In sum, present counterforce capabilities of the U.S. ICBM force may be significant or marginal, depending on how broadly or narrowly one defines the counterforce task. The attainment of a counterforce hard-target kill capability is technically feasible, and it goes to the very heart of U.S. strategic nuclear policy: What do we expect of strategic offensive forces, and what kind of posture are we trying to maintain? Although neither a consensus nor unequivocal answers are likely to be forthcoming, a resolution of the counterforce issue would seem to demand nothing less than both.

Limited Strategic Operations

(U) The Secretary of Defense has stated that "as national policy, we shall continue to acquire and be prepared to implement a number of more limited response options."* Such options would provide the President with flexibility in contingencies less than a general nuclear war, would provide a series of measured responses to aggression which have some relation to the provocation, have prospects of terminating hostilities before general nuclear war breaks out, and leave some possibility for restoring deterrence. "Our objective remains deterrence, but modern deterrence across the spectrum of nuclear threat."*

~~(C)~~ Now generally called Limited Strategic Operations (LSOs), the concept involves the controlled use or the threat of use of limited numbers of strategic nuclear weapons against selected civil or military targets. The background context is rather ill-defined at this time:

*(U) Ibid.

Some view LSOs as political/coercive events designed to alter the target nation's crisis situation assessment and decision processes; others see it as escalation in an ongoing conventional conflict, possibly leading to general nuclear war. Many agree, however, that while preplanning is important, no amount of preplanning will be able to eliminate surprises if a limited strategic conflict occurs. The essential factors in coping with surprises are believed to lie in the flexibility of national security institutions and in the variety of weapon capabilities.

(U) Among the potential advantages of ICBMs for LSOs are positive C^3, quick response, flexible targeting, high-confidence penetration, and accuracy. These features are generally accepted both as applicable to the ICBM force and as desirable for LSO planning. But they are not exclusive with the ICBM force. Consider C^3 for example. Only if Soviet strikes escalate to a level outside the intended scope of LSOs, or if they are selectively attacked, are CONUS C^3 facilities likely to be disrupted. It follows that in the conditions and circumstances usually associated with LSOs, secure C^3 will be available to *all* of our strategic forces.

(U) In assessing the attractiveness of ICBMs over SLBMs for LSOs, the case may rest on other than the widely appreciated differences in delivery accuracy or assured two-way command communication. "It is not primarily accuracy.... A submarine like the Poseidon is hard to adapt to [LSOs] because you have so many MIRVs permissible and so many missiles per boat. As soon as you fire, you expose the boat. Consequently, the ICBM is a far more useful instrument for this kind of strategy than is the SLBM."*

(U) It is not evident that the targeting flexibility or accuracy of the ICBM force is superior to that of the strategic bomber force, or that the penetration capabilities of the ICBM are better than those of the SLBM. Although ICBMs--in the aggregate--may fulfill the requirements of LSOs better than bombers or SLBMs, neither has this been demonstrated, nor its importance established.

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*(U) Statement by Secretary of Defense James R. Schlesinger in a hearing before the Subcommittee on Arms Control, International Law and Organization of the Senate Committee on Foreign Relations, March 4, 1974.

~~(S)~~ Challenges to the LSO capabilities of the ICBM force may be found in the prospects for destroying hardened targets and limiting unwanted collateral damage. While the targets selected for LSOs may differ, depending on the initiating scenario and the intent communicated, they may include targets from soft to superhard. But as shown in Table 3, the hard-target kill capabilities of the current U.S. ICBMs are marginal unless multiple RVs are allocated to each target. Apart from the cited difficulties in targeting multiple RVs against a single point target, it is also conceivable that more than one weapon per target would be undesirable in those circumstances where the *numbers* of nuclear weapons employed, per se, have significance as signals of intent.

(U) This also raises the question of whether the multiple weapons of the Minuteman 3 may be less selectively employable than the single weapon of the Minuteman 2. If collateral damage considerations override, the lesser yields and the higher accuracy of the Minuteman 3 are preferable, although its multiple RVs might not be desired.

(U) The suitability of ICBMs for LSOs has also been questioned on the *psychological* effect of their first use. While the strategic bomber force has been employed in limited conflicts with conventional weaponry, ballistic missiles have never been associated with anything other than general nuclear war. The introduction of ICBMs into a conflict at a stage where escalation control is the paramount concern could be viewed as a precarious step. On the other hand, one objective of LSOs involves the notion of conveying coercive signals of resolve, dire warning, and deep alarm, and the use of ICBMs could contribute to these signalling objectives.

~~(S)~~ In sum, the LSO capabilities of the ICBM force may be more widely accepted in general than they are demonstrable in specifics--at least in comparison with our other strategic offensive forces. In the political and military contexts generally applied to LSOs, it is not clearly evident that the capabilities of the ICBM force in any single aspect are unique. The relative attractiveness of ICBMs over other strategic offensive force elements for LSOs probably lies in their potential for extremely high accuracy and high confidence delivery

coupled with unquestioned--if not singular--capabilities for quick response, flexible targeting, and positive C^3.

OTHER ISSUES

(U) There are several other important issues which seem to arise indirectly from perceptions of the survivabilities and capabilities of the ICBM force. Three of these issues are sufficiently controversial and durable to warrant discussion here. They are the stability, safety, and cost of the U.S. ICBM force.

Stability

(U) It is widely held that opposing ICBM forces, if mutually capable or threatening the survival of their counterparts, are unstable forces. One form of instability is perceived to lie in the incentives for each side to attack preemptively in a crisis (crisis instability); that is, to use its ICBMs before losing them in an opponent's attack. Such an instability is seen to be aggravated by increasing the kill capabilities or the vulnerabilities of the ICBM forces on either side. Since increasing vulnerabilities are not actively sought, but follow from an opponent's increased kill capabilities, concerns for the stability of opposed ICBM forces are most evident in discussions of potential improvements in ICBM capabilities to kill hard targets.

(U) The charge that opposing ICBM forces may be unstable by inviting preemptive attacks in a crisis has evoked several counterarguments. One of the simplest is that ICBM forces do not possess the capabilities for confident disarming attacks against their counterparts. Another is that a successful disarming attack against ICBMs is insufficient in a world that also contains SLBMs and bombers, especially if that attack is an awesome provocation because of the necessarily large amounts of force expended. Still another counterargument is that such attacks would not be contemplated because of the risk that the threatened ICBMs would be launched out from under the impending attack.

(U) The implications of these opposing arguments are not likely to comfort anyone but their proponents. One view supports the unilateral abandonment of hard-target kill capabilities or even of the

entire ICBM force. The other view suggests that there is no need to worry, because the attacks will not really work and, therefore, will not be attempted. Unfortunately, the issue is also beclouded when other, broader interpretations of stability are invoked, especially those of *arms race* stability.

It has been theorized that opposing ICBM forces may stimulate spiraling increases in the ICBM force levels--an arms race instability. Such an instability is theoretically aggravated by increasing the kill capabilities or the levels of survival required of the ICBM forces on either side. Further, if the level and capabilities of the survivors are required to be sufficient to restore a balance between the opposing ICBM forces, stable force levels are theoretically unobtainable. At least one of the objectives of SALT is to halt spiraling force levels.

While such theoretical considerations provide a logical basis for speculating on the role of ICBM forces in the dynamics of arms races, they do not appear to be supported by serious historical research. Other factors--political, institutional, and economic--seem to be more important determinants of ICBM force levels than do the abstract criteria of strategic theory and calculus.

In sum, the stability of ICBM forces is an issue that is not sharply focused, in large part because the concept of stability is itself subject to arguments over its definition or relevance. What can be said with some confidence is that there is much wider accord about the assumption that ICBM forces *are* unstable than there is about the definition, context, or significance of instability. That assumption is likely to persist as long as the indictment of ICBM force instability rests on simple (or naive) logic, while its refutation continues to depend upon more complex (or esoteric) considerations.

Safety

The presence of the ICBM force in CONUS, as it may affect nuclear deterrence and public safety, is an explicit issue in some of the arguments over land versus sea basing for the missiles. The presence of the force in CONUS can alternatively be viewed as an undesirable invitation to nuclear attacks upon our homeland or as an awesome and desirable deterrent to opportunistic attacks upon our strategic forces.

One view is that "the very existence of ICBMs" has made the land mass of each superpower "an irresistible magnet for the strategic offensive force of the other."* Thus, the ICBMs, "by their very presence in the heart of North America, are endangering the people they are supposed to protect."† This view has been expressed in advocating the sea basing of strategic forces as a direction for SALT negotiations.

The opposite view has been taken on the basis of the philosophy of deterrence. "Our land-based systems may be thought of as assuring a determined response by requiring a nuclear attack on U.S. territory if they are to be disarmed. By some calculations of deterrence, this may be the most desirable attribute of land-based systems."‡ "Unpleasant as it may be, it appears that the risk of causing collateral fatalities is a positive deterrent to Soviet first strike counterforce attacks, and is an element in our deterrent posture."**

The argument, then, pivots on which risk should be of greater concern: the risk of collateral damage if deterrence fails, or the risk that deterrence might fail in the absence of collateral damage prospects. While both risks may be appreciated as valid concerns for national safety and security, they are fundamentally different in focus and philosophy. One is a concern for the *consequences* of conflict, while the other is a concern for the *occurrence* of conflict.

From either point of view, the amount of collateral damage that might be caused by an attack upon the current ICBM force--especially as compared to attacks upon other strategic force elements--is pertinent. Damage estimates, particularly predictions of fatalities due to fallout, are notoriously uncertain; but the results of some representative calculations may be cited to indicate the general levels of expected damage.

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*"The Vulnerable Homelands" by Commander Paul H. Backus, USN (ret.), *U.S. Naval Institute PROCEEDINGS*, Vol. 96, No. 12/814, December 1970.

†"The Only Option" by George E. Lowe, *U.S. Naval Institute PROCEEDINGS*, Vol. 97, No. 4/818, April 1971.

‡Comment and Discussion by Robert I. Widder, *U.S. Naval Institute PROCEEDINGS*, Vol. 98, No. 4/830, April 1972.

**Comment and Discussion by Dr. Russel D. Shaver, *U.S. Naval Institute PROCEEDINGS*, Vol. 97, No. 11/825, November 1971.

~~(S)~~ For attacks upon hardened silo-based ICBM forces, the principal potential for collateral damage is from fallout; casualties due to prompt weapon effects are negligible by comparison. One estimate of the fallout fatalities from an attack with one surface-burst 5-MT weapon upon each of 1,223 sites associated with the U.S. ICBM force is about 13 percent of the U.S. population, assuming negligible shelter protection.* The estimation uncertainties are illustrated by another calculation for a similar attack--but using a different analytical model†--which puts the fallout casualties at between two and fourteen percent, depending upon wind variations.

~~(S)~~ One important dimension in these estimates is the weight of the attack; another is the intent of the attacker: whether or not he takes pains to minimize collateral damage. Still another dimension is the degree of fallout protection assumed. For example, an attack with 1-MT weapons, detonated at or near optimum height of burst, upon the bulk of the U.S. ICBM force--the 850 Minuteman missiles in the remote northern CONUS sites--might result in fatalities as low as 0.15 percent of the U.S. population, assuming maximum utilization of existing civil defense facilities.‡

~~(S)~~ This wide range of estimates--varying by a factor of almost 100 within plausible sets of assumptions--probably has significance only when compared with estimates of collateral damage for attacks on the other strategic offensive force elements. For attacks on the strategic bomber force, the principal potential for collateral damage is the casualties due to prompt effects. An attack with a single airburst 1-MT weapon over each of 45 SAC air bases has been estimated to

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*(U) *Nuclear Vulnerability Analysis/Damage Assessment Handbook* (U), Vol. I, National Military Command System Support Center, TR-5A-66, 31 December 1970 (Secret).

†(U) L. H. Wegner, *Quick Count: A General War Casualty Estimation Model*, The Rand Corporation, RM-3811-PR, 1963 (For Official Use Only).

‡(U) *Briefing on Counterforce Attacks*, Senate Hearings before the Subcommittee on Arms Control, International Law and Organization of the Committee on Foreign Relations, 11 September 1974.

result in fatalities due to prompt effects of about 0.15 percent of the U.S. population. But an attack with twice as many 1-MT weapons on 93 air bases (including the dispersal bases) has also been estimated to result in fatalities of 10 percent, or if the weapons were surface-burst (to get the runways), between 7 and 25 percent, depending upon the winds. Thus, the estimates of collateral damage for attacks upon the U.S. ICBM or bomber forces are comparable both in level and variability.

~~(S)~~ If 2-MT weapons were surface-burst at each of seven submarine berthing sites, the fatalities due to prompt effects are estimated at about 0.1 percent. If the attacks were limited to a single 1-MT weapon on each of the two CONUS bases for missile submarines, the fatalities have been estimated to be on the order of 0.05 percent of the U.S. population.

(U) In sum, the estimated civil casualties associable with an attack upon each of our major strategic offensive force elements is highly dependent upon the assumptions of the attack and upon uncontrollable variables. The variations are sufficiently large to becloud any sharp comparisons between strategic force elements. Attacks upon the missile submarines in port are estimated to result in fewer fatalities than attacks on the ICBMs or bombers, principally because fewer targets (and weapons) are involved. But as a general proposition, it can be said that for comparable weights of the attack, the estimated casualties associable with each force are likely to be closer to each other than the range of estimates that can be found for any single force element. Thus, the fault or virtue of the ICBM force--depending upon the individual viewpoint--is that an effective counterforce attack is likely to require a very heavy attack. Whether that should be viewed as a deterrent to attack or as a danger from attack is the pivotal point of the safety issue.

<u>Costs</u>

~~(S)~~ The cost of maintaining the present U.S. ICBM force does not appear to be a contentious issue. The Minuteman hard silo deployment was engineered with low operations and maintenance costs as design

objectives. The evidence of that effort can be seen in the annual operating cost of about $.31M per Minuteman silo, as compared with $1.5M for each Titan 2.

(U) More visible and controversial costs are those associated with the continuing R&D programs for modernizing or improving the ICBM force. While specific programs, such as those for improving the counterforce capabilities of Minuteman 3, have gained visibility because of their costs, their opposition is more likely to derive from policy implications than costs. The total R&D and procurement programs in support of the ICBM force are small in the context of strategic force expenditures, but they are large enough (at about five hundred million dollars each year) to provoke debate during the funding cycles.

(U) One view is that these programs should not be funded, since land-based ICBMs are becoming obsolete; such funding would be better devoted to the development of weapon systems which promise a longer life.

(U) An opposing view is that the land-based ICBMs will be retained indefinitely because of their capabilities and despite present (and contested) concerns about their future survivability. It is held that technical and developmental problems will continue to arise from the changing operational environment of the future, and that adaptation to these changes requires a vigorous R&D and force modernization program.

(U) In sum, it does not appear that the costs of the present U.S. ICBM force, either for operations or for modernization programs, are crucial issues. Rather, it seems likely that the costs of the present force, by comparison with the costs for other strategic force elements, are favorable qualities. The costs for ICBMs may become a crucial issue only if a major development program is sought for a new missile, for new basing, or both.

III. ICBM FORCE IMPROVEMENT OPTIONS

(U) A very large number of technical options have been proposed for the improvement of various specific aspects of the ICBM force. These options represent possible responses to the issues outlined previously; collectively they define the technological future possibilities for the force.

(U) The options described here range from relatively minor modifications of the existing force to the development of new missiles and basing concepts. The objectives of this display of options are to illustrate the breadth of technical responses to issues, to outline systematically the major proposed alternatives, and to indicate some of the fundamental pros and cons. The options are *not* presented as preferred technical solutions; any selection of options must be based on an evaluation in depth.

(U) The options are organized here into four categories. The first two, options for improving force *survivability* and *capability*, are discussed primarily with reference to the existing Minuteman system, but many of the options would apply equally to any follow-on ICBM system. The third category encompasses options for the development and deployment of a new advanced-technology ICBM, and the fourth category covers the options for the redeployment of the force in new basing structures.

(U) Not included in any of these four categories are options oriented toward *elimination* of part or all of the ICBMs. They include reducing or eliminating the force by deliberate steps, as well as permitting obsolescence through neglect. While these options may be responsive to some points of view on the issues outlined previously, their *evaluation* does not depend upon the technical considerations within the scope of this review.

SURVIVABILITY ENHANCEMENT OPTIONS

~~(S)~~ The possible options to improve force survivability are discussed here in reference to prelaunch and postattack/enduring survivabilities. Options for improving in-flight survivability against

pindown (X-ray) and environmental hazards are not discussed here because both the problems and possible countermeasures are covered by existing programs. Rebasing options are discussed separately beginning on p. 60.

Improved Prelaunch Survivability

(U) The options for improving the prelaunch survivability of the current ICBM force are not numerous. As a result of the SALT agreements, two major options to improve Minuteman survivability are not now available: passive defense measures are limited to *existing* silos and active defense is banned. However, since the ABM treaty can be terminated by either side on six months' notice, active defense remains an important potential option for improved survival. In addition to improved silo hardness and the technical requirements for a capability to launch the force on attack assessment, our discussion of options for improving prelaunch survivability includes a controversial proposal for exotic defense measures which would create a lethal environmental cover over (and in) the defended areas.

~~(S)~~ Hardness Upgrading. The Minuteman silo system hardness is

EO 13526 Section 1.4(g) Section 3.3(b)(8) [redacted]

isolation system presently is believed to control the composite system hardness; the silo structural elements are harder. One option for further hardness upgrading is still further improvement in the missile shock isolation system with, perhaps, compatible improvements in certain other facility elements.

~~(S)~~ Missile canisterization is one very promising possibility for increasing the hardness of the system in place and providing for launch mode flexibility. Studies have shown that a common canister is feasible for the MM-3 and its possible growth versions for both silo and some mobile basing modes. The canisterized missile can be shock-isolated to about twice the upgraded silo hardness. The cold-launched canister system is also effective in protecting the missile against both the

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*(U) Reported vulnerability numbers range from 41P6 to 45P5, reflecting different estimates and different damage levels.

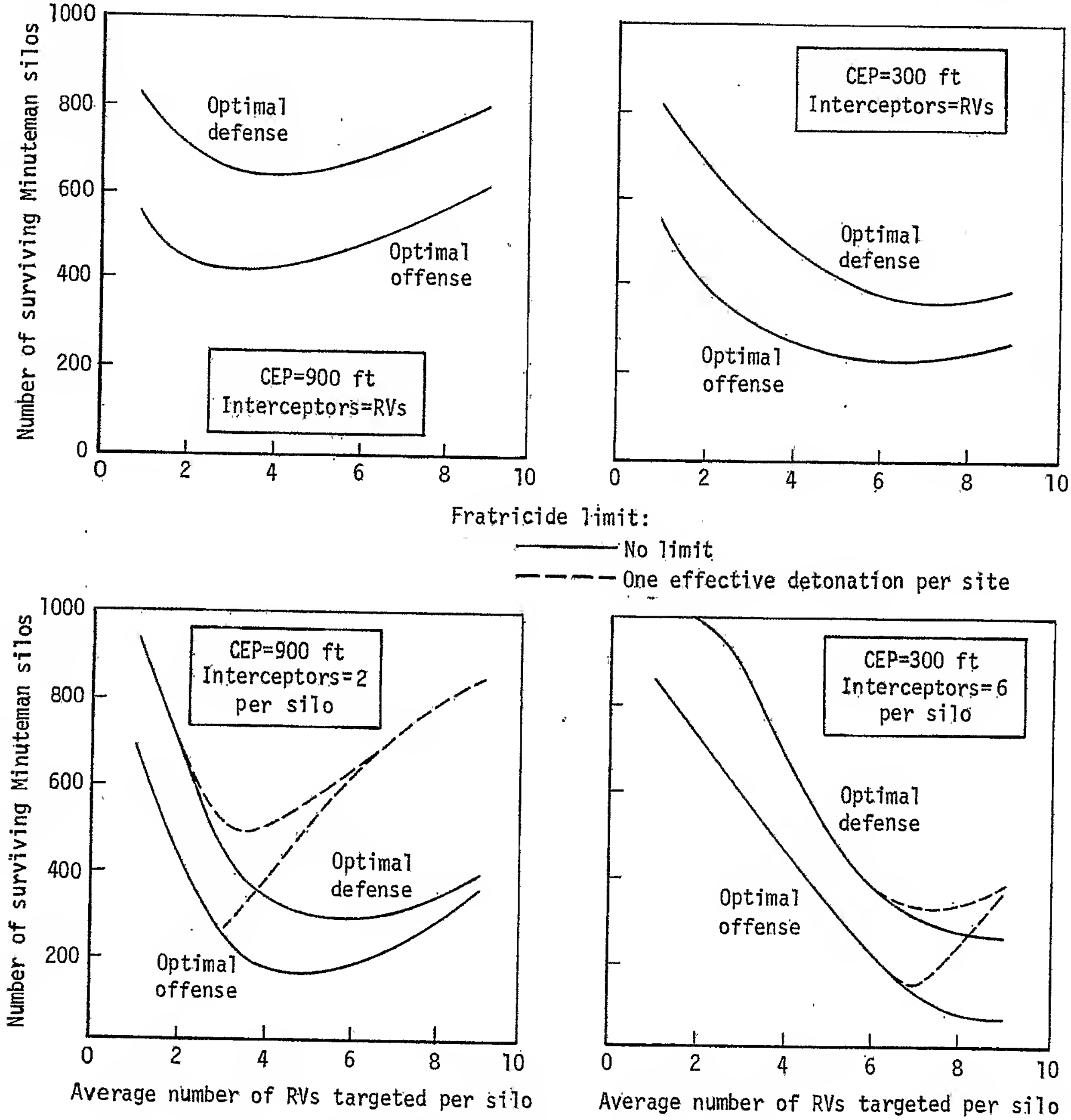
debris environment and silo tilt that may result from a nuclear attack. The principal question is whether upgrading hardness *alone* is a worthwhile counter to the anticipated threats, unless it is done as a part of a more extensive program to improve force survivability.

(U) Hard Site Defense. While banned by the ABM Treaty, hard site defense remains a potential option for improving the prelaunch survivability of ICBM forces. The effectiveness of hard site defense is largely determined by the interplay between interceptors and RVs; the target kills occur only through RV leakage until the interceptors are exhausted; thereafter the attack can proceed free of defensive interference. While influenced by the RV/interceptor allocation doctrines and capabilities, target kill through RV leakage is generally not very effective. Any reasonably effective defense system will let only a small fraction of the RVs of any attack wave get through until the system is depleted.

(U) Thus, to be effective against hard site defenses, the attacks must exhaust the interceptors. However, this is not simply a matter of numbers because of certain self-limiting effects. First, within a given throw weight, the number of RVs can be increased only by dividing the payload into smaller and smaller warheads, thus reducing the kill effectiveness of individual RVs unless compensated for by greatly improved guidance accuracies. Second, and perhaps more important, multiple attack waves are required to exhaust several interceptors at each silo. Depending on the RV leakage rate, some RVs will kill silos, but they will also form fireballs growing to nuclear clouds laden with dust and debris, ultimately forming a high altitude dust cover over the battle area. The seriousness of these interactions will increase with each succeeding attack wave.

(U) In sum, the calculated effectiveness of hard site defense is generally attractive until the defense is exhausted; and the process of exhausting several interceptors per site by multiwave attacks may be self-limiting in its effectiveness.

~~(C)~~ The potential effectiveness of hard site defense of Minuteman is illustrated by simplified calculations in Fig. 8. Optimal or preferential defense against uniform attacks and optimal attacks



(S) Fig.8—Minuteman hard site defense effectiveness as a function of heavy ICBM MIRV payloads (U)

(1000 41P6 silos attacked by 250 heavy ICBMs, each with 4 to 36 RVs, basic Rel_{nr}=0.9, RV leakage=0.2)

against uniform defense interceptor/RV allocation doctrines make a sizable but not a drastic difference in the outcome. As is shown in the upper graphs, the Minuteman force cannot be annihilated unless the defense is exhausted; a significant fraction of the silos will survive even if the effects of fratricide are neglected. This is caused by the self-limiting effects of dividing the MIRV payloads into smaller-and-smaller-yield RVs. Attempts to exhaust the defense, as shown by the lower graphs, bring out the question of how many attack waves could get in without serious kill or dispersion of the RVs. It is now generally accepted that two waves are the limit if sites are undefended. While more waves might be possible against defended sites, the one-in-five leakage of RVs assumed in the illustration results in a detonation and possible closing of penetration time windows at most sites after a few attack waves. As an upper bound, the dashed lines in the illustration show one effective detonation with undegraded CEP at each silo. Hard site defense can preserve, even under this limit assumption, a sizable fraction of the Minuteman force, especially at larger CEPs. Smaller CEPS could be countered by more interceptors, the exhaustion of which may not be possible, because of the fratricide effects.

(U) Launch on Attack Assessment. A credible capability to launch the ICBM force on attack assessment requires systems for assessing the attack and then implementing appropriate launch command and targeting procedures. The main objectives of attack assessment are: to determine with high confidence that an attack is in progress, to assess the nature and intent of the attack, and to provide decisionmakers that information in time to act. An attack assessment system would consist of surveillance sensors, communication networks, capabilities for near-real-time data processing and display, and capabilities for data integration and analysis. With current sensors, the potentially available information times for attack assessment are shown in Table 4.

~~(S)~~ It has been estimated that Minuteman launch procedures could be modified to permit the missiles to reach safe altitudes in about seven minutes after a Presidential decision to launch. As is seen in Table 4, attack assessment is potentially in time to permit the Minuteman to escape ICBM but not SLBM attacks on the silos.

(~~S~~) Table 4

SURVEILLANCE INFORMATION TIMES FOR ATTACKS BY SLBMs AND ICBMs (U)

Time from Soviet Launch (min)	SLBM Information		ICBM Information	
	System	Content	System	Content
EO 13526 Section1.4(a) Section 3.3(b) Section 3.3 (b)(4) [redacted]				

[a]Also from other sources, including bomber pilots.

(U) Attack assessment information provides but one input to the ICBM launch decision process. Other inputs may be the prevailing world situation and information available from intelligence sources. As an attack develops over time, assessment information can assume two aspects: First, the strategic nature and purport of the attack (how many attackers, from where, going where, and when?) and, second, the tactical particulars of the attack (which, depending on the quality of the attack assessment system, may include the identity of the specific target, attacker type, and time of impact).

(U) Because of the relatively short times available, a credible decision process must include a preplanned set of decision criteria, involving at least two considerations: (1) the attack assessment thresholds for considering launch commitment, and (2) the level of confidence in assessment information for launch decision. The first may weigh the consequences of launching versus not launching; the second may require, for example, confirmed reports from several information sources of numerous Soviet warhead detonations in the U.S. heartland before the decision to launch is made.

(~~C~~) The credibility of the U.S. capability to launch ICBMs on attack assessment will also depend upon having a credible targeting

plan for the force that is launched. In the absence of a good hard-target kill capability, missile silos are probably not attractive targets. Attacks on air bases, C^3 facilities, and suppression of air defenses to permit bomber penetration might be a more effective use of resources. Good hard-target kill capability (e.g., single-RV probability of target kill greater than one-half) may permit effective attacking of missile silos in a counterforce exchange, especially if the attack assessment system can provide empty hole information for use in rapid retargeting of the force.

~~(C)~~ In sum, launch on attack assessment can be technically implemented as a credible strategic option. The foreseeable technical problems are that the required warning and detection systems are relatively vulnerable to precursor nuclear attacks and the available warning times are not sufficient against SLBM attacks (either pindown attacks or attacks on silos).

~~(S)~~ Environmental Defense Systems. "Environmental defense" has been used to describe the (proposed) use of deliberately timed nuclear detonations in the defended area to generate nuclear clouds which might serve as high-altitude protective covers over the area. A related concept is to use the high-intensity neutron flux shields from relatively small-yield nuclear detonations as point defense systems. Such proposals have been considered by some as potential emergency defense options for the Minuteman.

~~(S)~~ The envisaged nuclear clouds would consist of dust, rain, and water particles forming an erosive environment that could destroy or degrade the accuracy of incoming RVs. To be most effective, the clouds would be formed by heavy-yield (5 MT or higher) surface or shallow-buried bursts. For Minuteman silo deployment densities, one such burst is estimated to protect about 7 silos at 5 min and about 13 silos at 10 min after detonation by creating an environment lethal to SS-9 Mod 4 RVs. Hence, a few defense detonations per wing could protect a sizable number of Minuteman silos against massive attacks of nearly simultaneously arriving RVs.

~~(C)~~ Environmental defense concepts could be developed to a point that would permit their rapid deployment in the event of some sudden

and unexpected deterioration in the U.S. strategic deterrence posture. In this sense, it might serve as a bold and inexpensive insurance policy to buy time for other improvements in the strategic forces. The obvious major disadvantage is the requirement to detonate a substantial "friendly" megatonnage within the northern regions of the U.S., a prospect fraught with strong political and emotional overtones (although the collateral effects from clean defense weapons might compare very favorably with those from massive attacks on undefended targets). In addition, environmental defense would be critically dependent upon high-confidence attack assessment systems because of detonation timing problems and limited shield endurance, unless the shield is renewed by additional detonations.

Postattack and Enduring Survivabilities

(U) The options to improve Minuteman launch availability in the postattack period include: (1) improvements in the survivability and reliability of the standby power units to extend ICBM launch endurance past the first day, and (2) dormancy of the missiles to reduce maintenance and postattack power requirements, thereby extending the endurance to many weeks or even months.

~~(S)~~ Potential improvements in the existing standby power systems include hardening of the external generators and fuel supplies (now much softer than the silos) and better start-up/switch-over reliability. Another option is to use small nuclear power reactors or high energy density heat sources with an energy conversion system within each silo. These options could increase the launch availability of the force at the end of the battery life, but they cannot forestall the eventual system degradation due to limited postattack maintenance.

~~(S)~~ Dormancy of the missiles is a completely different approach to maintaining the launch availability of the surviving force. Only minor changes in the existing system hardware are required to permit the missiles to operate in either the active or the dormant mode. When dormant, all subsystems are turned off except those of command and control and perhaps the sump pumps in wet sites. The missiles can be returned to active alert status in 6 to 10 min.

(~~S~~) Dormant operation of a large fraction of the Minuteman force would overcome both the standby power survivability and reliability and the postattack maintenance problems. A smaller fraction of the force could be operated in an active mode, permitting rapid reaction. The Minuteman guidance systems have been dormancy tested with excellent results. However, past Air Force evaluations of partial dormancy have brought out differences of opinion about the effects on system accuracy, reaction time, turn-on failure rates, and manning requirements that remain unresolved at this time.

CAPABILITY IMPROVEMENT OPTIONS

(U) The options to improve ICBM capabilities are discussed here in terms of improving the capability of the force to execute major strategic tasks: countervalue (CV), counterforce (CF), and limited strategic operations (LSO). Most of the specific options considered would improve the force's capability to execute more tasks than one. For example, throw weight increases benefit both CV and CF tasks, and guidance accuracy gains are beneficial in CF and LSO tasks. Since the ICBM capability for CV tasks is not controverted, except on survivability grounds, the improvement options are discussed first in reference to CF tasks, with some options having overlapping implications for other tasks. This is followed by a discussion of options specifically oriented toward improved capabilities for LSO tasks.

(U) Another group of possible options, not discussed here, involves improvements in ICBMs' penetration of enemy defenses. Since large-scale active defenses are currently banned by the ABM Treaty, however, future availability of these options on timely bases requires a vigorous R&D program to maintain U.S. technological superiority, to avoid technological surprise, and to inhibit Soviet abrogation of the treaty.

(U) The options associated with a new missile are discussed separately beginning on p. 56.

Improved Counterforce

(U) Several options are available to improve the capability of the present ICBM force in counterforce attacks through better target

coverage and hard-target kill potential. These include increasing throw weight, increasing the yield from throw weight, improving accuracy, and going to an all Minuteman 3 force.

~~(S)~~ Additional options would permit a more effective use of hard-target kill capability in counterforce exchanges. One is to provide the ICBM force with the means for effectively using bomb damage assessment (BDA) and empty hole information during a series of exchanges. This requires a capability for very rapid retargeting of RVs. Explicit retargeting is one way to reduce retargeting times; it may also be useful in LSOs. Advancing technology may permit the development of self-contained reconnaissance/BDA capabilities with terminally guided RVs.

~~(S)~~ All Minuteman 3 Force. The U.S. ICBM force would be significantly more effective in CF operations if Minuteman 3 missiles replaced the Minuteman 2. Figure 9 shows the single-shot kill probabilities of Minuteman 2 and Minuteman 3 RVs against Soviet missile silos. With currently reported CEPs, each of the three Mk-12 RVs of Minuteman 3 is a slightly more effective hard-target killer than the single Mk-11C RV of Minuteman 2, so each of the present Minuteman 3s equals about three Minuteman 2s in effectiveness. Projected CEP improvements and the new Mk-12A RVs (under development) will increase the Minuteman 3's effectiveness further: two Minuteman 2s must be launched against a target to produce about the same kill probability as that achieved by each of the three RVs of the Minuteman 3. Hence, each of the Minuteman 3s will equal about six Minuteman 2s in effectiveness. But as is seen in Fig. 9, significant kill capability against the new hard missile silos can be achieved only with Minuteman 3s at the projected CEPs, aided by the new Mk-12A RVs.

~~(S)~~ Improved Throw Weight/Range. The Minuteman's throw weight and range can be improved by further, evolutionary modifications to the missile, similar to those made in the past. A completely new missile of the same weight and within the dimensions of the Minuteman 3, but using advanced technology, would about double its payload to 3,500 lb at 6,000 n mi. For evolutionary changes, of course, the gains would be somewhat less, but the options are numerous. As an example,

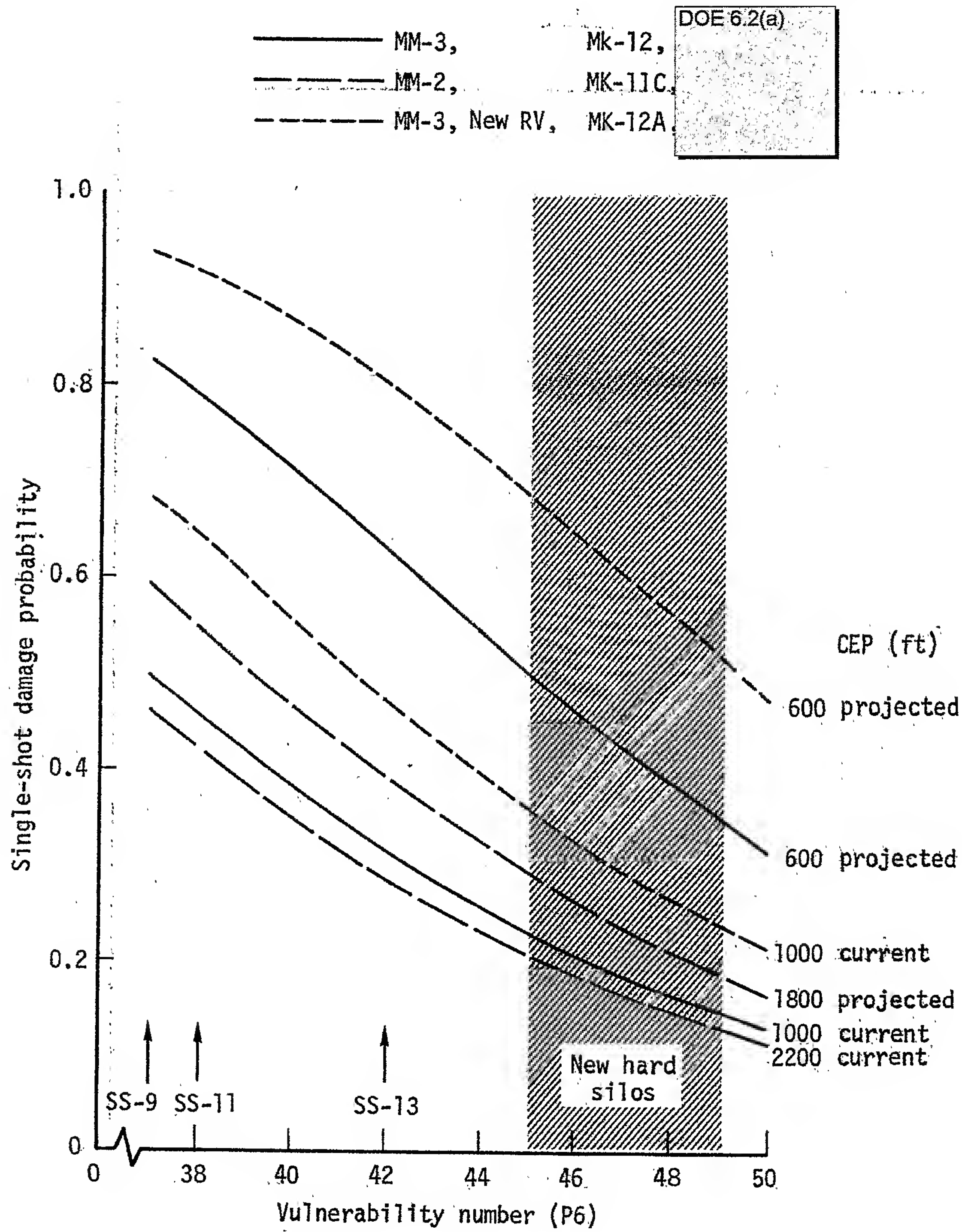


Fig.9—MM-2 and MM-3 hard-target damage capabilities (U)

one Minuteman 3 improvement option, using a new second stage and replacing the first stage nozzles with a single nozzle, would increase the missile's throw weight to about 2,500 lb.

~~(S)~~ Improved Warhead Efficiency. The current Mk-12A development program is using advanced warhead technology to about double the yields of Minuteman 3 warheads within the existing Mk-12 weight and dimensional constraints. A similar option is available to double the yield of the Mk-11C RV on Minuteman 2 at no appreciable increase in weight.

(U) ICBM Accuracy Improvement. The options for improving the accuracy of the ICBM force may be divided into three broad alternatives:

Continuing improvements and refinements of the current all-inertial systems,

Development and exploitation of external artificial navigational aids, and

Development and exploitation of sensors utilizing external (natural) phenomena as navigational aids.

(U) These alternatives are not mutually exclusive, of course. The use of external navigational information has generally been proposed as an adjunct for in-flight updates of the inertial guidance system (reducing the guidance system errors) or combined with the use of maneuvering reentry vehicles (MaRVs), for trajectory adjustments during the reentry and terminal phases (also reducing or eliminating the nonguidance errors).

(U) The currently proposed guidance system concepts in the above three categories and their potential accuracies are summarized in Table 5. The all-inertial systems depend on accurate knowledge of the launch point's initial conditions. If not accurately known, as in many mobile systems, guidance accuracies are correspondingly degraded. In general, systems using navigational aids do not require launch point information, and their accuracies are largely independent of the missile basing mode. Stellar/inertial systems fall in between: since the star scanner information can reduce the initial uncertainties in the launch point position and platform alignment but not in the velocity vector, their accuracy will depend on the basing mode and how well the initial conditions are known.

~~(S)~~ Table 5

OPTIONS FOR IMPROVED ICBM ACCURACY (U)

Approach	System		Type of RV	Launch Point Initial Conditions Required	CEP (ft at 5,500 n mi)	
					Guidance	Weapon System
All-inertial	As seen by: Proponents		RV	Yes	115-260	380-450
	Skeptics		RV	Yes	350-500	500-700
Radio overlay	Post-boost		RV	No	150-200	300-430
	Late midcourse		RV	No	80-110	240-380
	GPS to reentry		MaRV	No	Nil	70-150
Environmental sensors	Stellar-inertial		RV	Yes, but	Depends on how well initial conditions are known	
	Terminal Guidance	TERCOM	MaRV	No	Nil	200-400
		Radar area	MaRV	No	Nil	80-150
		Optical	MaRV	No	Nil	30-80

~~(S)~~ All-Inertial Guidance Systems - Opinions differ on how much further improvement is technically possible. Skeptics see limits in the ability to maintain the required dimensional stabilities, to field-calibrate accelerometers to the required accuracy, and to transfer performance in the laboratory to performance in flight. The advantages of all-inertial systems are that they are self-contained, that they are impervious to countermeasures, and that their technology base is well established.

~~(S)~~ External Navigation Aids - Systems using a radio overlay need a radio-measurement subsystem aboard missiles and a ground- or satellite-based (GPS) system of transmitters. Although either system can be used for post-boost and midcourse measurements, only GPS (global positioning system) transmitters can reach MaRVs for trajectory corrections during reentry. The use of radio aids complicates the system and may thereby reduce its reliability. While the ground-based transmitters should be relatively inexpensive and difficult to countermeasure, the GPS transmitters may require extensive development, may be more easily countermeasured, and will depend on the satellites' survivability.

~~(C)~~ Environmental Sensors – Various sensors could be used in terminal guidance systems to establish a position fix for MaRVs. The constraints imposed by weather and lighting vary with the sensor, as does the obtainable accuracy. Terminal guidance systems will require a sensor, guidance-and-control, and computer package in each MaRV, with a corresponding reduction in the warhead yield. They are more complex and probably less reliable than the pure inertial or radio-inertial systems, and, because they must operate in the target area, they may be more subject to countermeasures. Terminal sensors will also require extensive acquisition and reduction of target data; they will complicate the problems of rapid and flexible retargeting of missiles.

~~(S)~~ Explicit Retargeting of RVs. Explicit targeting of ICBMs by latitude and longitude is believed to be the most direct and efficient method for reducing the retargeting times (probably to less than a minute). If developed for the Minuteman 3 missiles, it would require new computer software and perhaps a new airborne computer. Combined with bomb-damage assessment information, explicit retargeting capability would permit rapid reallocation and launch of threatened missiles on attack assessment (the present Command Data Buffer is too slow). It could also be useful in LSOs against targets for which there were no precomputed target data.

~~(C)~~ ICBM-Based Reconnaissance/Terminal Guidance Capability. There have been several proposals to use MIRV buses as platforms for sensors and as data links to give the ICBM-based system a near-real-time reconnaissance capability for bomb damage assessment or for terminal guidance of its MaRVs or both. The concept envisages a high-resolution, synthetic-aperture, side-looking radar for all-weather target detection, data transmission via bus-based data links or special data relay vehicles, and central data processing in CONUS or aboard a C^3 aircraft.

~~(C)~~ An important aspect of this concept is its potential use for "recce strike" missions against either fixed or mobile targets. Surviving elements of a fixed target set could be recognized and attacked.

Mobile targets, such as land-mobile ICBMs or naval vessels, could be attacked given prior knowledge of their approximate positions.

Limited Strategic Operations

~~(S)~~ The main requirement in LSOs is for the weapon to execute a desired task with high confidence, while limiting undesired collateral damage. This may require positive C^3, quick response, flexible targeting, efficient hard-target kill, and high-confidence penetration. Some options to improve counterforce capabilities, e.g., improved guidance accuracy and explicit retargeting, respond also to LSO requirements. Other options are available specifically to improve LSO capabilities. Discussed below are options to minimize collateral damage and to rapidly reload silos to maintain an unimpaired second-strike capability. Also treated is the concept of an elite ICBM force wherein a part of the ICBM force is equipped with special, enhanced capabilities for prompt and flexible use in LSO.

~~(S)~~ Options To Minimize Collateral Damage. One option to minimize collateral damage from LSOs is to minimize the yield required to achieve a desired damage probability. This can be done most directly through improved accuracy. However, since the targets of interest in LSOs may range in hardness from soft to superhard, targeting flexibility may require the use of single-RV missiles with a variable-yield warhead. Both the yield and fuzing of the warhead could then be selected on the basis of the target hardness and desired damage, expected CEP, and collateral damage considerations.

~~(S)~~ Another option for reducing collateral damage is the use of earth penetrating RVs. Fallout and blast effects are largely eliminated

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Section 3.3(b)(8)

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the hard-target kill effectiveness of the buried RVs.

(U) Silo Reloading Capability. A capability for silo reloading would permit rapid replacement of missiles launched in LSOs and therefore would maintain a continued LSO and an unimpaired second-strike

retaliatory capability. The importance of this capability depends on perceptions of the size and timing of LSOs.

(~~S~~) The hot exhaust gases of missiles launched from current operational silos would destroy much of the equipment in the silo. The refurbishment of a silo has been estimated to take about one year and to cost about $1 million. An appropriate hardware protection system could be designed that would cut the refurbishment time to a few days. Plans and procedures would also be needed to provide for replacement missiles and equipment and for crews to rapidly reload the silos.

(~~C~~) Clearly, the resource requirements of silo reloading depend on how many missiles must be reloaded how quickly. While the proposals for cold-launched encapsulated missiles are motivated primarily by interest in increased throw weight and hardness, they also could simplify reloading the silo.

(~~C~~) Elite ICBM Force. This is a concept to equip and maintain a part of the ICBM force with special, enhanced capabilities appropriate to the prompt and flexible use of ICBMs in LSOs (and perhaps even in theater nuclear war). Even though LSOs are probably the most demanding of the strategic tasks in ICBM capabilities, these demands do not include severe requirements for initial or enduring survival. Thus, the present silo basing seems quite adequate for an LSO-configured elite ICBM force. (Larger Soviet attacks on the elite force imply escalation of nuclear violence to a level calling for responses beyond limited strikes with special capabilities.)

(~~S~~) In concept, an elite ICBM force could be constituted by stipulating special procedures and by providing special system capabilities to a designated part of the Minuteman force. Among the special procedures, the elite force might have appropriate C^3 systems and links to higher command echelons and special launch-enable procedures to permit rapid responses to the National Command Authority. The elite force might be given priority in all planned improvements in the force, such as the Command Data Buffer being deployed today. For targeting flexibility, precomputed target data on suitable LSO targets could be kept current at all times. If guidance system aging is shown to be an important factor in degrading accuracy, special replacement procedures

could be used to keep the guidance systems young. To deter Soviet LSO attacks against the elite force, the force could be protected under the Safeguard umbrella, by designating either all or a part of Minuteman Wing VI at Grand Forks AFB as the elite force.

(~~S~~) The special capabilities that could be provided for in the elite force include RVs designed to reduce collateral damage and some one-RV payloads with numerous height-of-burst options. Explicit retargeting could be provided to enhance the flexibility in the selection of targets. It may be possible to improve the confidence level of the performance of an elite force by techniques such as the Trajectory Accuracy Prediction System (TAPS) to determine whether the missile guidance is good. To maintain both a continued LSO capability and an unimpaired retaliatory capability, the force could also be provided with a rapid silo reloading capability.

NEW MISSILE OPTIONS

(U) An important set of options for enhanced ICBM capabilities is associated with developing and deploying a new advanced-technology missile. These options open up possibilities for significant increases in throw weight and range for improved target coverage and hard-target kill capabilities, while providing opportunities to incorporate various detailed improvements in both the missile and the reentry systems.

(~~S~~) While numerous concepts for new missiles have been examined, the principal differences are in (1) the deployment mode (deployment in existing silos, rebasing, or a multimode deployment) and (2) the front end (selection or optimization of the MIRV payload). Deployment modes are important because of the weight constraints they may impose on new missiles. In general, most rebasing systems can accommodate large missiles; concepts for offroad-mobile systems have specified missile weights up to 270 Klb. Road-mobile systems are the apparent exception; in unhardened vehicles they would be limited to about 40 Klb by highway legal load limits.

(U) New missiles deployed in the existing silos must, of course, be dimensionally compatible with the silos. The several options and constraints are outlined below. A subsequent section explores the MIRV payload/yield combinations possible in the various missile sizes.

New Missile Options for Retrofit

(S) Compatibility With Existing Silos. Minuteman silos can accommodate missiles considerably larger than Minuteman (76 Klb). Missile weight limits are controlled by ground transportation. The heaviest object that can be moved over roads (special permit) is 90 to 100 Klb (plus the transporter/erector). If this were the weight limit for assembled missiles, a payload of about 4,000 to 4,500 lb could be expected. If that weight were the limit for unsegmented first stages, corresponding to a total missile weight of about 150 Klb, the payload would be about 7,000 lb. Larger solid-propellant missiles must be transported with segmented first stages and assembled at the launch facility. The largest missile that can be assembled in an existing silo without sacrificing the upgraded silo hardness, has been estimated to be in the 250 to 300 Klb class.

(S) Hot Flyout Versus Missile Canisterization. The size of new missiles depends also on the desired launch mode. Hot flyout from the existing silos is possible with missiles up to about 100 Klb. Larger missiles must be canisterized for cold ejection launch. However, canisterization may be desirable, even for smaller missiles, because of (1) deployment mode flexibility (a common canister system may be feasible for both silo-based and land-mobile missile systems) and (2) enhanced hardness (a canister system can be easily shock-mounted and made less sensitive to the effects of surface or crater debris and silo tilting).

(C) Solid Propellants Versus Liquid Propellants. Solid-propellant missiles will be generally preferred for mobile deployment for convenience in ground handling and transportation. Liquid-propellant missiles may have some advantages in retrofitting existing silos if the missiles are very large, because the one-time missile transportation and assembly problems would be simplified.

(S) Interim Agreement. While the Interim Agreement prohibits the conversion of land-based launchers from light into heavy ICBMs, it does permit force modernization. There is an "initialed statement" that in the process of force modernization and replacement, the dimensions of land-based ICBM silo launchers will not be significantly increased.

There is also a "common understanding" that the term "significantly increased" means that an increase will not be greater than 10-15 percent of the present dimensions of land-based ICBM silo launchers. There is no agreed interpretation of the term "heavy ICBM." There is only a unilateral statement by the U.S. Delegation that any ICBM having a volume significantly greater than that of the largest light ICBM now operational on either side is considered to be a heavy ICBM. The largest light ICBM is the Soviet SS-11 with cylindrical envelope volume of about 3,200 ft^3. While the term "volume significantly greater" has not been defined, a 15-percent increase, analogous to the above-mentioned silo dimensions, will give a volume of 3,700 ft^3, corresponding to a missile weight of about 195 Klb and a payload of about 9,000 lb. This may be the largest light missile possible within the U.S. interpretation of the Interim Agreement.

Illustrative New Missiles and MIRV Payloads

~~(S)~~ On the basis of the above considerations and assuming the Air Force's MX Program technology and 6,000 n mi range, some missile-weight/payload combinations are listed below.

Weight (Klb)	Payload (lb)	Weight Criterion
40	1600	Heaviest road mobile missile, soft transporter/launcher
80	3500	Minuteman 3 weight class
100	4500	Heaviest assembled missile road/bridge transportable
150	7000	Heaviest missile with unsegmented 1st stage road/bridge transportable
195	9000	U.S. interpretation of heaviest "light" ICBM under Interim SAL Agreement

(U) The MIRV payload/yield combinations possible for the above missiles are illustrated in Fig. 10. Numerous MIRV payloads are available for the larger throw weights; their hard-target kill effectiveness depends, of course, on weapon accuracy. The yield/CEP combinations necessary for a 0.9 kill of typical Soviet hard targets are illustrated in Fig. 11.

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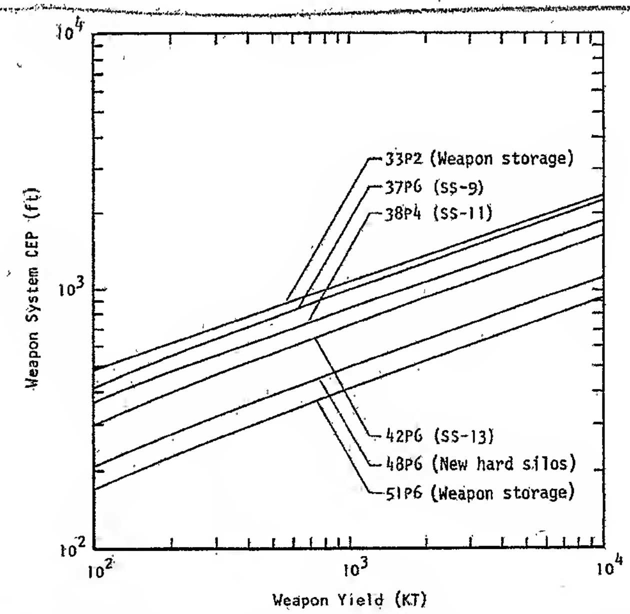
(~~S~~) Fig.10—MIRV payload/yield combinations (U)



(~~S~~) Fig.11--Yield/CEP combinations of reliable weapons for 0.9 damage probability against selected hard targets (U)

(S) Some MIRV payloads for hard-target kill are shown in Table 6. Weapon system accuracy is a primary input: the CEP/yield combinations shown are required for 0.9 kill of the new hard Soviet silos (48P6 or about 3,600 psi at one MT assumed here; current intelligence estimates are not available). The number of such RVs possible is then shown as a function of missile payload.

(S) Table 6

NUMBER OF HARD-TARGET KILL RVs
VERSUS MISSILE PAYLOAD (U)

(0.9 kill of 48P6 targets)

ICBM Payload (lb)	CEP (ft)/Yield (KT)		
	300/250 (RVs)	600/1700 (RVs)	900/5000 (RVs)
4500	8-10	3	1
7000	12-14	4-5	1
9000	14-16	5-6	2

NEW/SUPPLEMENTARY ICBM BASING OPTIONS

(U) New basing concepts offer the most exciting and decisive determinants for the future of ICBMs. Over the years, a large number have been proposed, studied, and debated. Most of the concepts have been put forward as means for improving the survivability of the ICBM force. But beyond that common objective, they are not easily resolved into an orderly array of possibilities. Basing concepts are most often categorized by design features: fixed or mobile; silo, shelter, or pool; road, rail, or canal transport, etc. These classifications are descriptive of the required hardware and facilities, but they are not very helpful in comparative evaluations or in assuring comprehensive consideration of the alternatives.

(U) Here, a more fundamental approach to ICBM basing concepts and their classification is appropriate; so we begin with some general considerations of the parameters that ultimately define the survivability characteristics of the force. These parameters provide a

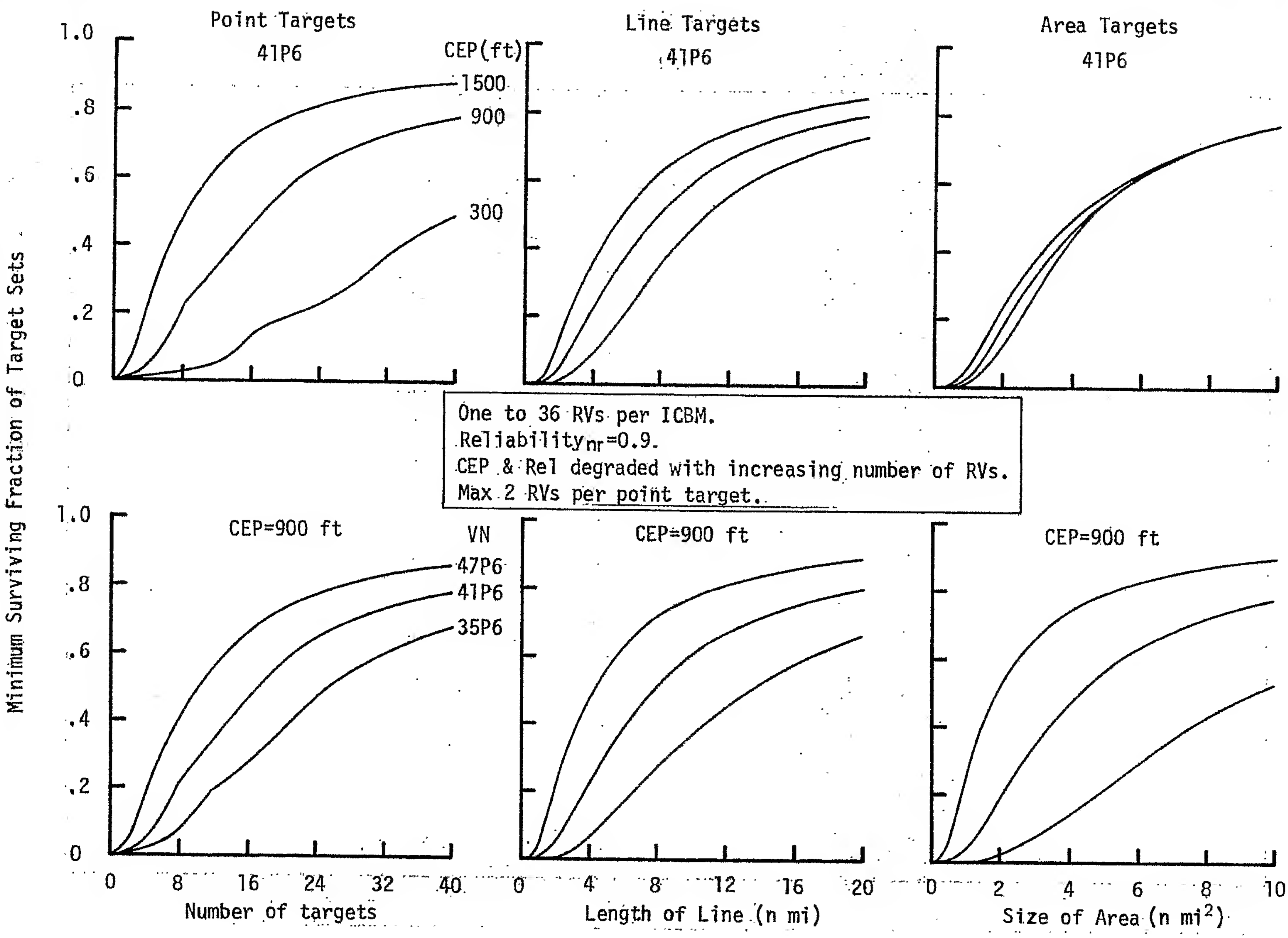
logical structure within which the diverse proposals for new basing may be generically classified and then systematically reviewed for their technical, operational, and economic features.

Some General Characteristics of ICBM Basing

(U) The most important single parameter defining the survivability characteristics of any basing is the kind of target geometry presented to the attacker; that is, whether his targets are point, line, or area target arrays. (Deep space basing of ICBMs would theoretically constitute a volume target array, but such basing is now prohibited by the Outer Space Treaty of 1967.) The target geometry, the array size (number and spacing of points, lengths of lines, or area size), and the target hardness of a given basing system determine both the attack requirements and the inherent survivability of missiles deployed in that basing system. These fundamental relationships are illustrated in Fig. 12 for three different target geometries.

(U) Each of the curves in Fig. 12 represents the minimum surviving fraction of a target array as a function of array size. For missiles distributed randomly in the target arrays, this is also the minimum expected surviving fraction of the missiles deployed. The array sizes are all normalized against an attack by one Soviet heavy ICBM and scale directly with the attack size (number of ICBMs), so the figure illustrates survivability against fixed throw-weight threats. The MIRVed payloads are theoretically optimized for maximum target kill; hence, the number of RVs and their yield vary from case to case as a function of target geometry, array size, hardness, and the attacker's CEP.

(~~C~~) The upper curves of Fig. 12 show the effect of CEP on survivability, plotted for target hardness (41P6). It can be seen that target geometry determines the relative importance of attack accuracy: point targets are very sensitive to CEP improvements, line targets somewhat less, and area targets hardly at all. Array size increases survivability up to a point of diminishing returns; such a point can be determined for each target geometry, hardness, and CEP.



(S) Fig.12—Survivability of target sets attacked by one optimally-MIRVed Soviet heavy ICBM

~~(C)~~ The lower curves of Fig. 12 show the effect of target hardness on survivability, plotted for the same CEP (900 ft). The differences between line and area geometries are less pronounced, but it is apparent that area targets are more sensitive to hardness than point targets. In sum, point targets are more sensitive to CEP and benefit less from hardening than other geometries. Conversely, area targets are relatively immune to CEP improvements and can benefit more directly from increased hardness. The characteristics of line targets, of course, lie between the two.

(U) While the target geometry presented to the attacker is a basic determinant of survivability, the rich spectrum of missile basing concepts derives not so much from differences in target geometry as it does from the diverse means for *enforcing* any given geometry upon the attacker. Obviously, an ICBM is not an area or line target unless the basing scheme makes it so by *generating* and *maintaining* a geometrical array that must be attacked to kill the missile.

(U) The most common means for *generating* a credible geometry is through some form of missile mobility, usually by either redeploying or being able to redeploy the missiles to any arbitrary location within the intended target array. The modes of mobility include: continuous movements of missiles, intermittent movement initiated in response to either intelligence cycle times or attack warning, and no movement after initial deployment in the array.

(U) The target geometry generated by mobility is subject to collapse through the determined efforts of the attacker. Reconnaissance and surveillance activities may be able to resolve missile locations within the intended target array and provide timely targeting information for an attack. *Maintaining* a credible geometry in the face of such efforts may be accomplished by various tactics applied either to the missile movements or their sites. Such credibility tactics include concealment, deception, or even overt operations.

(U) The foregoing general considerations are basic to all basing concepts; they provide a framework within which proposed basing schemes can be identified and classified. Table 7 shows most of the familiar basing concepts systematically arranged in a matrix whose dimensions

Table 7

CLASSIFICATION OF ICBM BASING SYSTEMS

Target Geometry	Credibility Tactic	Mobility Mode			
		None	Intermittent, Responding to		Continuous
			Intelligence	Attack	
POINT	OVERT	Missile silos DUB/Overt exits	Shell game/Random Air base hopper	Shell game/Dash	
	DECEPTION	Silos + Decoys	Shell game/Decoy TLs		
	CONCEALMENT		Shell game/Concealed		
LINE	OVERT		Road Rail Barge	Road/Dash Rail/Dash	Road Rail Barge
	DECEPTION		Road, Rail, Barge/ Disguised Road/Disguised/On strategic warning		Road, Rail, Barge/Disguised
	CONCEALMENT	(Concealed lines with "frozen" missiles)	Canal basing Soft tunnels/No portals Trench/Soft cover		Canal basing
AREA	OVERT		Offroad-mobile VTOL hopper Sea sitter	Offroad-mobile Air-mobile/Strip alert VTOL/Dash Sea sitter/Dash	Offroad-mobile Air-mobile/Air-borne alert BMS/Undisguised
	DECEPTION		Offroad-mobile + dummies		Offroad-mobile + dummies BMS/Disguised
	CONCEALMENT	DUB-Concealed exits	DUB/Dig out Submersible Barge FBM Submarines		FBM Submarines

DUB = deep underground basing   BMS = ballistic missile ships   TL = transporter/launcher

are target geometry, mobility mode, and credibility tactic. Any ICBM basing scheme can theoretically be placed in an appropriate box in such a matrix. There are several advantages in structuring new basing concepts according to the dimensions of Table 7. First, it groups together those concepts which have the same fundamental survivability characteristics (same target geometry, same mobility mode to generate the geometry, and same credibility tactic to maintain the geometry). Thus, the comparative evaluation of concepts within the same box can be made primarily in terms of cost.

Second, the matrix enforces comprehensive consideration of the alternative concepts for ICBM basing. The crossed-out boxes represent combinations which seem logically inconsistent and are, therefore, not expected to be a source of basing options. All other boxes have been considered as possibilities for basing schemes. Thus, concepts for basing that may be proposed in the future are expected to be variants of previously considered types rather than generically new types.

Finally, each filled box in the matrix represents a *generic* basing option, exemplified by one or more specific proposals. These generic options provide the structure and a suitable level of aggregation for a systematic review of the technical, operational, and economic features of new basing for the ICBM force.

Point Targets

Missile silos are a familiar system of point targets with many desirable characteristics such as low operating costs. However, since each silo houses a missile, force and target array survivabilities are equal; and the force can be drawn down rather rapidly by accurate, MIRVed threats. Options to enhance the survivability of point target systems fall into two categories: (1) deep underground bases (making the missiles nontargetable by the enemy) with many launch exits (to maintain sufficient launch capability), and (2) shell-game missile systems, with many redundant shelters and missile mobility (to maintain aimpoint credibility). Akin to the latter is a system of missile silos and inexpensive decoy silos, except that the missiles are "frozen" in their silos and rely solely on long-term deception for credibility.

(U) Deep Underground Basing with Overt Launch Exits.* Deep underground missile bases could store the missiles in virtually invulnerable facilities. Since the stored missiles are nontargetable, all can be assumed to survive. (Except for certain area target systems, all basing concepts require missile proliferation for enhanced survivability.) Missiles can be launched through a system of exits, each capable of multiple launch. Although overt exits have the individual survivability characteristics of point targets, overall survivability may be improved if a few surviving exits are able to launch the entire force. A small surviving fraction of launch exits could be converted to 100-percent survival of launch capability.

~~(S)~~ The potential advantages of basing missiles deep underground include, in addition to the physical survival of the force, the possibility for deploying the force in compact areas unobtrusive upon the public. The force could also be provided with postattack maintenance for enduring survivability. Since the response times and firing rates might be relatively slow (of the order of 30 min) the force may not be suitable for LSO and counterforce roles; but it should have excellent stability characteristics. The main concern with the concept is assuring that the missiles can get out--much of the total cost of the system goes into building of launch exits. The number of exits needed for adequate survivability depends on the threat, including that of transattack surveillance and reattack that might close the initially surviving exits. While banned by the ABM Treaty now, a preferential active defense overlay is a feasible way to preserve a desired number of exits.

(U) The development of deep underground bases will require a major technology effort both to increase the confidence in and to reduce the cost of such systems.

(U) Shell-Game Missile Systems. Shell-game missile systems achieve survivability through redundant aimpoints. Aimpoints could be silos, garages, pools, or other shelters designed to conceal and provide hardness to the deployed missiles. Hardness could be achieved

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*(U) Concealed launch exits are discussed under "Concealment Line Target Systems," beginning on p. 71.

by shelters alone or by combinations of shelters and missile capsules. Discussed below are the two basic issues of shell-game systems: target credibility and the relative shelter-to-missile cost.

(U) *Target Credibility*--Shell-game systems achieve survivability through aimpoint leverage: several shelters must be targeted to threaten one missile. It follows that the basic requirement of the systems is target credibility: all shelters must be equally credible aimpoints to preclude the array size from collapsing to the number of missiles deployed. Discussed below are the four schemes listed in Table 7 for maintaining shell-game target credibility.

(~~C~~) Overt Random Redeployment - This concept assumes that the detection of missiles parked in shelters (either by covert or overt agents or sensors) leads to relatively long intelligence cycle times (ICT). Target compromise by such long ICTs could be countered by random redeployment of missile transporter-launchers (TL) with an appropriate redeployment cycle time. Since the detection of TL movements by covert means is expected to result in equally long ICTs, the main threat of detection comes from orbital sensors which could, in principle, provide near-real-time surveillance of TL movements. However, since TL movements from one shelter to another should take only a few minutes, detection by satellite sensors could be prevented by scheduling overt redeployment moves in darkness (optical), under cloud cover (IR and optical), or during predictable gaps in satellite coverage. All weather, day and night surveillance is possible only with synthetic aperture radar (SAR) or phased-array radar systems. In general, such threats of detection have been discounted: SAR systems require hundreds of satellites for frequent coverage (10-min average frequency). While phased-array systems can, in principle, provide continuous coverage, they can be jammed, or spoofed by decoys.

(U) Overt Dash Redeployment - In this concept TLs and crews would be stationed in central shelters ready to dash to a randomly selected adjacent shelter upon attack warning. As dash systems, they need reliable warning and speed commensurate with available warning times. However, they are also subject to the satellite surveillance systems discussed above. Since the attacker triggers the dash at a

time of his choosing, his one-time surveillance requirements to track the dash are greatly reduced. On clear days, the combination of a few optical sensor satellites and in-flight retargeting of RVs could make the effectiveness of this mobility mode questionable.

(U) Concealed Redeployment - Detection of TL movements can be prevented by concealment covers over road networks. However, inexpensive soft covers can be blown away by light attacks, forcing the system back to overt mobility. Harder covers are likely to be costly.

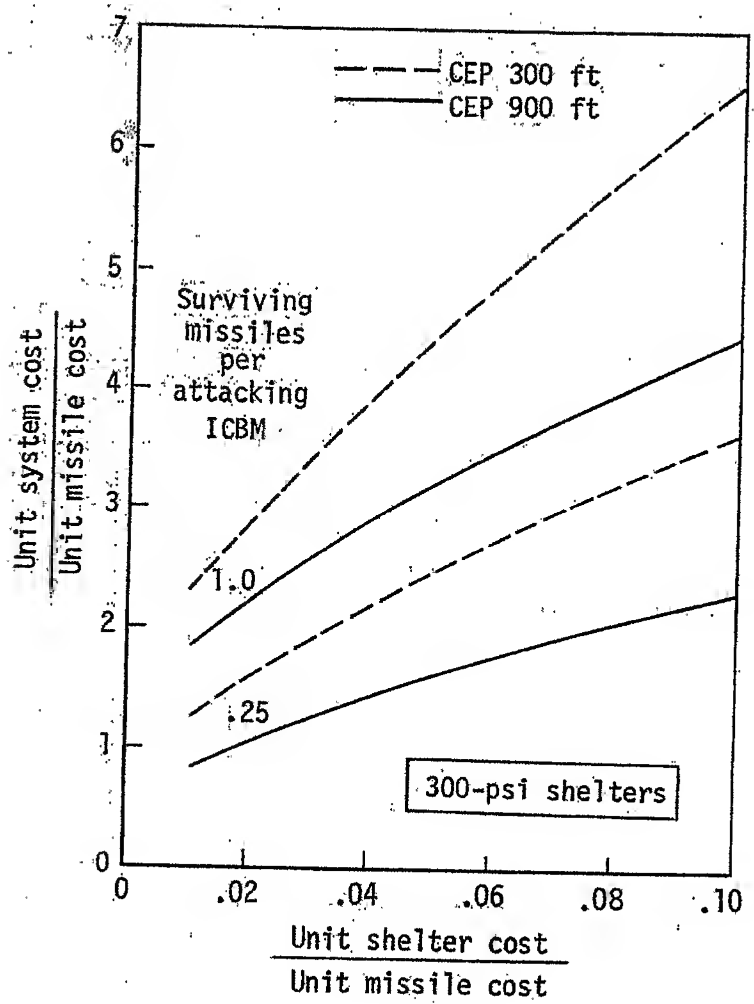
(U) Deception Redeployment - Deception systems could use both real and dummy missile canister-launchers and separate transporters. The canisters could be exchanged at random under a concealment cover. Deception systems will be more costly than overt systems and their transattack mobility may be degraded because the transporters are separate from the missiles.

~~(C)~~ In sum, shell-game target credibility can be maintained by overt random redeployment scheduled to avoid detection, provided, however, that continuous spaceborne radar surveillance can be ruled out either on technical and cost grounds or because of countermeasures. If not, target credibility will require the use of concealed or deceptive redeployment, both more costly than overt redeployment. Possible requirements for maintaining transattack credibility may also affect the choice of shell-game mobility modes.

~~(C)~~ *Cost-Effectiveness Considerations*--The cost-effectiveness of shell-game systems depends largely on the cost of shelters. This can be shown by using minimax system cost criteria for sizing the force. Unit missile and unit shelter costs are defined as *all* life cycle costs (procurement and operations) necessary to add either one unit equipment (UE) missile or shelter to the force. Thus, the life cycle cost of a system (exclusive of RDT&E) is the sum of UE missiles times their unit cost and shelters times their unit cost. Forces are sized to provide a desired surviving force against a specified threat, obtainable by different missile and shelter combinations. In a minimax cost model, the attacker maximizes his kill (optimal MIRVing and targeting) and thereby the cost of all possible combinations. The least costly of these maximum-cost forces is the minimax system cost force selected

by the defender. Figure 13 presents some typical minimax solutions for the system cost when normalized against threats by one optimally MIRVed heavy ICBM. These unit system costs scale directly with the attack size; for example, if systems with a $20 million unit missile cost are attacked by 300 heavy ICBMs, the cost ordinate is multiplied by 300 × 20 = $6 billion.

~~(S)~~ While the minimax system costs are driven up by increasing threat (either increasing throw weight or improving CEP) and depend on the desired degree of force survivability, they are greatly affected by the cost of shelters. The costs triple as the shelter-to-missile



~~(S)~~ Fig. 13—Minimax system cost of shell game systems normalized against one optimally MIRVed heavy Soviet ICBM

cost ratio increases from 0.01 to 0.1 (e.g., from $0.2 to $2 million in the case of $20 million unit missile cost). This cost ratio is a basic determinant of shell-game cost-effectiveness and can be used to compare and evaluate any proposed system concept.

(~~S~~) In optimizing shell-game systems, there is also a trade-off between the number and hardness of shelters, the optimal hardness depending on the relationship between hardness and cost. Of course, lower hardness levels need larger shelter separation distances and larger deployment areas. For example, 300-psi shelters need about 10 to 15 n mi^2 area to counter one optimally MIRVed heavy ICBM, 100-psi shelters about twice that area. These requirements are satisfied with land potentially available for shelter deployment, about 10,000 n mi^2 in military bases (dedicated DoD lands) and another 12,000 n mi^2 on contiguous Bureau of Land Management land.

Line Targets

(U) Line geometry targets, generated by missile TL movements over linear networks, constitute the second major group of target systems. Typically, overt and deception mobility concepts would deploy missiles via the public transportation systems. Rail-mobile Minuteman test trains were operated over the nation's railways in 1960. An important concern is the potential interface problems caused by the regular movement of nuclear weapons and the commingling of military and civil targets. Discussed below are a concept for a disguised road-mobile system designed to overcome some of the public interface problems and several concepts for concealment systems deployed over dedicated networks.

(~~S~~) Disguised Road-Mobile System.* Some of the public interface problems of road-mobile systems could be minimized by deploying at a few military staging bases TL vehicles disguised as commercial vehicles. Since these vehicles would be concentrated and soft, the system must be considered vulnerable to surprise attacks. On strategic warning, however, the missile carriers could be flushed to dispersal locations selected from among the several thousand smaller military installations

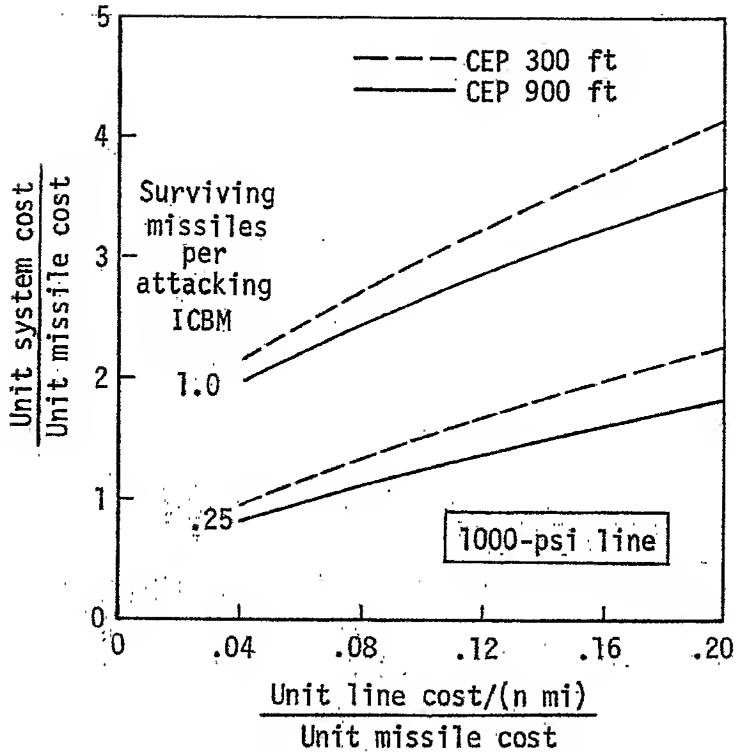
*(U) The concept may have numerous variants.

throughout the country. Since the disguised vehicles should not present recognizable signatures to satellite sensors, TL movements could remain hidden within nonmilitary traffic, and the carriers would be nontargetable until detected and identified. This concept should be considered as a special, low-cost basing option using small missiles (up to 40,000 lb within highway weight limits) and deriving their survivability from strategic warning.

(U) Concealment Line Target Systems. Concealment systems would generate line geometry by linear mobility under specially built concealment covers. These systems could be hardened to increase their survivability.

~~(C)~~ *Proposed Concepts*--Proposed concepts include those deploying submersible launcher capsules in canals and wheeled TLs in shallow underground cut-and-cover tunnels and in soft-covered trenches. Missiles could be launched from any point along the line. Typically, line hardness would be achieved by hard TLs or missile capsules rather than by a hard cover. With intermittent or continuous mobility, these systems could prevent detection and have equal preattack credibility. The main problem is transattack credibility. Light attacks might remove or destroy a soft trench cover, thus revealing missile locations and leaving them vulnerable to follow-on attacks. Canal systems may be vulnerable to cratering attacks and may drain. Although such draining might immobilize the capsules, submerged barriers and overhead culvert-type covers have been proposed to maintain concealment. (Critics have questioned whether there is enough water or level land for canal systems.)

(U) *Cost-Effectiveness*--The cost-effectiveness of concealed hard line systems, in analogy with shell-game systems, can be examined in terms of their unit system costs. Using unit missile costs as before and defining "unit line cost" as all system costs necessary to add one n mi of line, Fig. 14 presents some typical minimax system costs. The costs are much less sensitive to improving CEP and line-to-missile cost ratio than the corresponding costs of shell-game systems.



~~(S)~~ Fig. 14—Minimax system cost of hard line systems normalized against one optimally MIRVed heavy Soviet ICBM

Area Target Systems

(U) Area targets are least sensitive to CEP improvements, and they benefit most directly from hardness. Area geometry is generated by mobility on, above, or below the ground or sea surface. The type or mode of mobility and speed requirements depends on the credibility tactics used. Briefly discussed are possible overt and concealed area target systems. Deception systems might take the form of real and dummy TLs on land or disguised ballistic missile ships at sea.

(U) Overt Area Target Systems. Area target systems generated by overt mobility rely on speed to maintain target credibility, i.e., to escape aimed attacks based on detection and the associated ICT. If the speed is insufficient, the target area shrinks or the system becomes a set of point targets. Area targets are affected also by the operating media: land, sea, and air. Sea basing options include undisguised ballistic missile ships and "sea-sitting" amphibian aircraft. The

latter is a variant of air-mobile ICBM systems using both sea and air media for survivability. Briefly discussed below are land-offroad and air-mobile basing options.

(U) *Offroad-Mobile ICBM Systems*--Offroad-mobile systems could operate in two modes: dash in response to attack warning and movement in response to detection. Minimum speed requirements depend on available time, vehicle hardness, and threat. Some typical speed requirements are illustrated in Table 8 against threats by optimally MIRVed heavy ICBMs. ICTs based on in-flight retargeting of RVs are shorter than typical attack warning times (WTs); there is only one effective mobility mode against such threats--a very high dash speed to escape aimed attacks.

~~(S)~~ Table 8

MINIMUM TL VEHICLE SPEEDS (N MI/HR) TO OUTRUN
A PATTERN BARRAGE BY HEAVY SOVIET ICBMs (U)
(7 RVs @ 2.3 MT)

ICT or WT (min)	TL Vehicle Hardness		
	2 psi	10 psi	25 psi
30 Minimum ICT without in-flight retargeting	50	18	9
20 } Possible WTs for dash systems	75	26	14
15 } Possible WTs for dash systems	100	35	19
10 } Possible WTs for dash systems	150	52	28
6 } Possible ICTs with in-flight retargeting	250	87	47
3 } Possible ICTs with in-flight retargeting	500	174	94

(U) Dash systems are normally parked, ready for one-time dash-on-attack warning. The movement frequency in response to detection depends on both ICT and the detection frequency; for example, the coverage frequency of satellite surveillance systems. Such movements can be forced toward continuous mobility if both ICT and detection intervals decrease.

(~~S~~) About 480,000 n mi^2 or 21 percent of the total land area in CONUS is federally owned. Some 65,000 to 100,000 n mi^2 of this public domain may be suitable for offroad operations in the western United States. Other possibilities are deployments restricted to military bases, possibly including contiguous land from the Bureau of Land Management. To illustrate force survivability possible in these deployment areas, Table 9 shows the attack throw weight needed, as a function of missile vehicle hardness, to barrage the areas for 100 percent kill.

(~~S~~) Table 9

ATTACK THROW WEIGHT NEEDED TO BARRAGE DEPLOYMENT AREAS FOR 100 PERCENT KILL (U)

Deployment Area		Throw Weight (Mlb) TL Hardness (psi)			
Type	Size (n mi^2)	2	10	15	25
DoD (Military reservations)	10,000	0.07	0.57	0.86	2.0
DoD + contiguous BLM	22,000	0.16	1.3	1.9	4.4
DoD + public domain	65,000	0.46	3.7	5.6	13.0

(~~S~~) As is seen in Tables 8 and 9, offroad ICBM systems must be relatively fast in order to escape aimed attacks and relatively hard in order to minimize deployment area requirements for barrage attacks. The practical hardness limit of wheeled offroad TLs is 10 to 25 psi. For deployment, such systems would need all the public domain potentially available. Their speed requirements can be met for threats based on ICTs without in-flight retargeting and possibly for dash on attack warning. However, they would be unable to escape threats based on ICTs with in-flight retargeting of RVs. While speed could be increased by air-cushion, heavy lift helicopters, or VTOL-type vehicles, these vehicles are softer and may need more deployment area than is potentially available.

(U) *Air-mobile ICBM Systems*--Air-mobile ICBM systems would use large-payload, long-endurance aircraft as mobile ICBM bases in one or more operational modes.

(U) Continuous Airborne Alert - Airborne alert generates an area target with superior survivability under blind barrage attacks. Since routine peacetime operations over CONUS are believed to be precluded because of public safety, deployment is usually assumed to be over international waters supported from a few large coastal bases. While pattern barraging does not appear threatening because of the large available patrol areas, aircraft loitering over international waters may be exposed to a variety of as yet ill-defined technical threats of detection, tracking, and subsequent negation.

(U) Dispersed Ground Alert - Aircraft would be deployed with missiles and crews onboard, ready to scramble upon attack warning. Survivability is similar to that of a bomber-tanker force, with depressed trajectory SLBMs being seen as the main threat. Survivability depends on aircraft reaction time, escape speed, base location, and basing density. Collocation with the bomber force on existing bases is likely to intensify the bomber survivability problem, so additional bases may be required.

(U) Mixed Mode - Airborne and strip alert modes can be combined in a mixed mode where the force proportion would vary with the defense condition (Defcon) level. One concept would set crew ratios and maintenance facilities at a level permitting full airborne alert operations over a protracted crisis of several months.

~~(S)~~ The survivability of air-mobile systems depends on their deployment mode and on the quality and confidence of both strategic and tactical warning. In essence, survivability against surprise attacks demands continuous airborne alert. If strategic warning can be assured, a mixed mode with continuous airborne alert can be used during a crisis. If tactical (attack) warning can be assured, a strip mode can be used, provided the system has a reliable and compatible reaction and escape capability. In theory, reliable attack warning, with or without strategic warning, should lead to equal survivability. However, since the aircraft reaction time needed for safe escape is on

the order of 2 min, it probably cannot be maintained routinely without strategic warning. The system costs, of course, increase from strip alert to airborne alert (airborne alert may also have problems with fuel consumption).

(U) Independent of their deployment mode, air-mobile systems have limited postattack endurance aloft and must rely on a soft, targetable base structure for extended endurance, a problem shared with the bomber force. One proposed means for enduring survival is the use of large numbers of emergency dispersal sites for aircraft support and turn-around.

(U) <u>Concealment Area Target Systems</u>. While overt area systems rely on mobility and speed for survival, another alternative is to deny timely and useful targeting information to the attacker. The critical requirement then is to prevent detection with short ICTs rather than to outrun an attack. Submersible launchers are readily concealed in water, but concealment is more difficult in other media.

(~~C~~) Deep underground basing, discussed under "Point Targets," on p. 65, can be converted to an area target by the use of concealed launch exits. Concealed launch exits would terminate some distance below the ground surface, can be constructed from below without any observable signs or activity on the ground surface, and could be opened by an explosive system to permit missile launch in about an hour.

(~~C~~) Concealed exits would provide a hard area target, inherently the best of target geometries. Moreover, the cost of underground bases using concealed exits may be less than that of other basing. Once built, however, the exits depend critically on measures to maintain location security throughout the life of the installation. While secrecy may appear a cheap and attractive way of gaining survivability, it is also a risky one because one can never be confident of his secret. This vulnerability could be alleviated by providing a capability for reopening damaged exits or excavating new ones. With such a back-up, launch capability might be restored in a few days or weeks.

(U) Submersible barge systems, combining concealed area mobility and hardness, have been proposed as a low-cost alternative to FBM submarines. Deployment has been postulated in U.S. inland or coastal

waters that can be essentially closed to enemy antisubmarine warfare, removing the need for quiet submarines of high speed and maneuverability. The launch vehicle can be a relatively inexpensive submarine with reduced requirements for manning, speed, power, operating depth, and navigation and communication equipment. Possible deployment areas include the Great Lakes, Hudson Bay, Gulf of Mexico, the Alexander Archipelago off Alaska, and the coastal waters along the East and West Coasts.

Summary Observations

~~(S)~~ This review of the possible ICBM basing concepts does not indicate any "perfect" system. Some concepts face potential problems from satellite surveillance which might eventually provide near-real-time detection and tracking of overt mobile vehicles; others pose problems with the public interfaces they would generate. The more likely candidates at this time are shell-game, deep underground, concealed hard line, air-mobile, and submerged barge systems. These systems can all deploy virtually identical missiles. Delivery accuracies, availabilities, and reliabilities may differ, but not markedly. Larger differences appear in postattack endurance and force responsiveness. Major differences may also arise in SALT verification of forces.*

~~(S)~~ Any choice among the new basing options, of course, will be greatly affected by costs. The general cost-effectiveness trends of shell-game and hard line systems show that hard line systems are relatively more effective against smaller CEPs, but any final cost comparison will depend on the unit shelter and line costs. The cost of deep underground bases is mostly associated with the exit system. Austere ICBM basing in submersible barges or cheap submarines would seem to offer a clear cost advantage over ongoing development of sea-based systems. The cost of air-mobile systems can vary widely depending on the operational mode selected. Whatever detailed cost comparisons may

*(U) SALT considerations include a unilateral statement by the U.S. Delegation that "the U.S. would consider the deployment of operational land-mobile ICBM launchers during the period of the Interim Agreement as inconsistent with the objectives of that Agreement."

reveal about the choice of new basing options, it is very clear that rebasing for the purpose of enhancing the survivability of the ICBM force will be costly.

IV. AN ASSESSMENT

The foregoing perspective of current issues and future options for the U.S. ICBM force is intended as an objective background for decision-making. How that background is assessed as foreshadowing the future of the force depends upon some further, subjective considerations:

What are the *crucial* issues?
What views are taken on those issues?
Which of the available options are *responsive* to those views?

Answers to these questions are not necessarily singular; they may vary with people and time. While preparing this perspective, the authors have formed their own judgments on the answers. In this final section, we depart from the summary perspective and present our views and judgments on what all of this implies for the future of the U.S. ICBM force. Thus, this final assessment forms a separate, more subjective part of the report, rather than presenting the conclusions of a quantitative analysis. Our readers may represent a variety of viewpoints; they are encouraged to draw their own conclusions.

We see the most important and pervasive concern to be the preservation of the long-term capability of U.S. ICBMs to deter a preemptive nuclear attack, both in fact and in appearance, in the face of the foreseeable developing threat. The principal source of this concern is the large-scale Soviet deployment of accurate MIRVed missiles that could threaten the survival of U.S. silos.

Averting that possibility by negotiated limitations on MIRVs or throw weights is to suggest that SALT determines the future of the U.S. ICBM force. Avoiding the consequences of the threat either by abandoning the silos or rebasing the ICBMs, implies that a silo-based missile force is one the U.S. can or should do without. To ignore the concern is to deny both the scenario and rationale for strategic nuclear forces. While these futures are extremes which may *bound* the future of U.S. ICBMs, we find them neither attractive nor realistic as solutions.

THE PIVOTAL ISSUE

Instead of boundary solutions, we have sought the pivotal issue that, more than any other, might be a watershed for the future of the force. We submit that such a pivotal issue is whether each of the strategic offensive forces--ICBMs, bombers, or SLBMs--has some *unique role* within the U.S. strategic posture. If the ICBMs are considered simply as one of three different ways of doing the same job, then we are not sanguine about their prospects as key elements of the future U.S. strategic posture. However, if the ICBMs are seen to have a special role in the posture because of their unique capabilities and characteristics, then several interesting alternative futures are evident to us.

Resolution of this pivotal issue hinges not only on the *actual* characteristics and capabilities of ICBMs and on their *actual* role in the strategic posture but also in large measure on public *perceptions* of the job that ICBMs are supposed to do.

To suggest how decisive this issue may be, we offer below two very different prospects for the future of the force, depending upon how the question is resolved.

A FUTURE WITHOUT MUCH PROMISE

If the U.S. ICBM force is viewed as just one of three strategic offensive forces whose principal and common role is to deter a nuclear attack through assured retaliation, then the overriding concern will continue to be the survival of ICBMs in a preemptive attack. Comparisons among the three forces on the basis of survivability are invited simply because it is the basic common denominator of retaliatory capabilities. Other qualities, admirable or not, are likely to be discounted as not essential or central to the principal role of strategic forces.

The most responsive options for significantly improving the survivability of the ICBM force to a disarming attack are (1) to launch the force on attack assessment, or (2) to rebase the force. While there are other alternatives, they appear less effective or practical. For example, proposals to make the survivors more capable, such as

deploying larger missiles or more RVs per missile, will generally not be recognized as solutions, because the dominant perceived concern is force survivability--not the ability to execute some well-defined task requiring so much throw weight or so many RVs.

Further hardening of silos looks like a losing game in the face of increased missile accuracies. Active ABM defense may be a technically effective way to improve the prelaunch survivability of the ICBM force, but its acceptance is impeded by the restraints of the ABM Treaty and the emotional legacy of the ABM debates.

Launching the ICBM force on attack assessment is probably the simplest and most cost-effective way to frustrate a counterforce attack. But as a *declared* policy, we believe it would be vigorously opposed as both dangerous and unstable (an accident could theoretically precipitate a nuclear war).

Nevertheless, we believe that the *technical capabilities* to launch ICBMs on attack assessment should be developed *for their deterrence value*--so that no adversary would dare assume that the U.S. could not launch the force out from under any attempted disarming attack. They should not be costly. We also see such technical capabilities as providing additional flexibility in crises, where the declaration of an emergency readiness to launch the force on attack assessment could serve as an additional rung in an escalation ladder. But we do not go so far as to urge that the "survivability" of ICBMs be predicated on a policy of launching the force on attack assessment; the assurance of ICBM retaliatory capabilities should not rest upon such an awesome commitment.

The possibilities for improving the prelaunch survivability of ICBMs through rebasing are numerous, but we have seen none that look promising as a solution for the entire force. Our appreciation of the rebasing concepts now being considered for the U.S. ICBM force leads us to believe that if applied to the *entire* force, they would be very costly, of debatable effectiveness, and likely to sacrifice some important attributes (e.g., accuracy and security) of the present force. Of course, the search for rebasing concepts continues, but a good single solution is not yet in sight.

Diversified basing of the ICBM force has been proposed as a means to diversify vulnerabilities, but it will impose most of the same drawbacks as a single rebasing solution: it will be costly, there will be arguments over the relative effectiveness of the several basing schemes, and some of the better characteristics of the present silo basing are likely to be lost. Diversified basing concepts will result in a fragmented ICBM force; and if adopted primarily to improve the overall force survivability, each fraction will inevitably be subject to survivability comparisons with SLBMs. The failure of some portions of the ICBM force to measure up to the perceived survival standards of SLBMs would result in pressures to eliminate marginal or inferior fragments. Hence, piecemeal dismemberment of the ICBM force might be facilitated.

In sum, if the ICBMs have no unique role within the U.S. strategic posture, we do not see a promising future for them. Their evolution would then hinge upon overall force survivability, and we have not been able to identify any good force-wide options for relieving present concerns over ICBM survivability against a preemptive counterforce attack.*

SEVERAL PROMISING FUTURES

If it is accepted that each of the strategic offensive force elements could have a special role or roles within the U.S. strategic posture, then we see several interesting alternatives for the ICBM force. We can think of at least four special roles for ICBMs; perhaps there are more.

Limited Strategic Operations

While providing LSO capabilities cannot be claimed as the exclusive domain of ICBMs, we believe that ICBMs possess and promise more of the desired attributes for LSOs than any other strategic force element. If LSOs are a special role for ICBMs, the principal concerns will be to ensure effective and flexible targeting with minimum collateral damage.

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*Even though these concerns seem exaggerated to us. We believe they reflect a preoccupation with a narrow definition of the purpose of strategic forces, with extreme threats, and with simple analytics.

The prospects for controlling unwanted collateral damage while achieving the desired level of target damage are dominated by delivery accuracy. There is little doubt that the accuracy of ballistic missiles can be improved markedly with the technical means available; the questions have to do with whether we *should* improve ICBM accuracies (because of their counterforce implications), by how much, and by what means.

The highest possible weapon delivery precision should be sought for LSO capabilities. For some LSO tasks, zero-CEP via terminal homing is desirable so that the smallest possible yield, or even conventional explosives, can be employed where conditions dictate or permit. While reliance on terminal or external navigation aids for assured retaliatory capabilities might be eschewed, we see no reason why their benefits for lesser contingencies should be forsworn. For LSOs, we believe that ICBMs should not be restricted to all-inertial guidance. This imposes an unnecessary limit on delivery accuracy and, hence, upon the required weapon size and consequent collateral damage.

Options for improving the targeting flexibility of ICBMs for LSOs include additional C^3 functions, explicit targeting, variable yield, selectable fuzing, earth-penetrating weapons, etc. All seem worthwhile--at least in small quantities. None seem very costly compared to a new missile or rebasing the ICBM force. Perhaps the greatest impediment to their development is that they are *not* large-scale, force-wide program options.

Large numbers of ICBMs are not required for LSOs, nor are larger missiles with heavier throw weights. In some cases, MIRVs are liabilities rather than assets. In the present U.S. ICBM force, our most accurate missiles are MIRVed, and that could be awkward for some LSOs. A few very accurate single-RV missiles should be available.

Since large numbers of missiles are not required for LSOs, we believe that *elite force* concepts are attractive. Some of the features desired for LSOs could detract from the performance of other strategic tasks if implemented throughout the ICBM force. Moreover, high-confidence hard-target kill capabilities (for LSOs against selected hardened facilities) would not engender as much concern about their

counterforce potential if they were acquired only in limited numbers for an elite force.

An elite ICBM force for LSOs might consist of a squadron (50) or a wing (150) of Minuteman missiles. If the elite force were seen as presenting a preferential target for a Soviet LSO, it might be deployed in Wing VI at Grand Forks, under the Safeguard ABM umbrella. That arrangement might also be seen as advantageous in the rationale for maintaining a single Safeguard site: it could shift the principal threat scenario from an all-out attack to LSOs, a threat that may be technically less demanding (or overwhelming).

If we have any reservation about the potential future of the ICBMs for a special role in providing LSO capabilities within the U.S. strategic posture, it is not with the qualities of ICBMs, but with the concept of LSOs. It remains to be shown whether LSOs are a durable and useful concept contributing to deterrence. If they are, we think ICBMs will evolve as a principal instrument of that concept.

Assured Reserve Capabilities

Another special role is that of providing a reserve of strategic nuclear weapons that can be held inviolable and available for a long time in general nuclear war. While the abilities of U.S. strategic offensive forces to survive in the transattack period have been widely analyzed and discussed, far less attention has been given to the long-term survival of strategic forces in a seriously degraded postattack environment. Because of their relative autonomy during extended patrol operations, nuclear-powered submarines offer attractive survival characteristics (with the possible exception of assured two-way command communications) for periods of several months into a postattack period. Beyond that time, the breakdown of logistic support would probably limit the availability of SLBMs.

We believe that the U.S. ICBM force has several shortcomings for both immediate and long-term postattack survivability. The immediate survivability problem (past the first day) is tied up with providing electrical power, while the long-term problem in the following weeks is the same as for the SLBMs: logistic support. Both of these

problems could be favorably affected by making the missiles dormant. We believe that dormant operation of a portion of the Minuteman ICBMs would provide a low-cost reserve force with long-term survivability, at least until a significant Soviet counterforce capability emerges.

In the more remote future, if Soviet counterforce capabilities dominate the question of ICBM survival into the postattack period, rebasing of ICBMs for an assured reserve force may be an attractive option. One concept worth exploring is the basing of dormant missiles in secure underground bases.

The needed size of such a reserve is probably no more than a hundred megatons deliverable to several hundred separate aimpoints. The use of MIRVed missiles would reduce the required number of delivery vehicles, but they might be less manageable than a larger number of small missiles with single warheads. In any event, we do not see why reserve force missiles should be burdened with the features and costs for quick reaction, high accuracy, or sophisticated defense penetration.

SLBMs are certainly candidates for an assured reserve force. In a competition, land-based ICBMs may have two advantages: First and perhaps most important, ICBMs in underground bases are likely to be cheaper to store securely out of harm's way than SLBMs continuously at sea. Second, ICBMs can probably be stored (and controlled) considerably longer than the operational life of SLBMs without land-based logistic support.

Counterforce

If a special role for ICBMs is to provide counterforce capabilities, we see an interesting, but very controversial, future. Any investment of counterforce capabilities in the ICBMs will be seen by many as destabilizing, unless they are rebased to better survive any foreseeable Soviet attack. On the other hand, even if the ICBMs were more securely based, some would challenge the need for substantial counterforce capabilities unless the U.S. had aspirations toward a disarming first-strike posture. Either way, any attempt to develop a significant counterforce capability in the U.S. strategic posture is a journey on a bumpy road.

We are aware of some sophisticated arguments for acquiring (or threatening to acquire) counterforce capabilities, but we do not think they would carry the day in the present public debate.

The technical routes to substantial counterforce capabilities include improvements in hard-target kill capabilities through increased accuracies and yields, or through a larger missile with greater throw weight. There is little doubt of the technical feasibility of either approach. If constrained to the present missile, the most expeditious route might be to augment the inertial guidance with radio aids. With a larger missile, larger yields and greater numbers of RVs could compensate for the accuracy limitations of all-inertial guidance.

If ICBMs are rebased to make them relatively immune to attack, then the need for counterforce improvements beyond those needed for LSOs is hard to justify. Moreover, if the requirements for counterforce hard-target kill capabilities do not exceed those needed for LSOs, the qualities of the present fixed silo basing for LSOs seem preferable to those of most rebasing concepts. If counterforce capabilities well beyond those required for LSOs are somehow justified, then for a crisis-stable posture, the adopted basing scheme would have to enforce an unfavorable exchange upon the attacker in terms of counterforce capabilities expended versus those destroyed. Some of the basing options for a new ICBM now being studied by the Air Force meet that criterion, but so do sea basing options.

The possibility of investing any counterforce capabilities in SLBMs rather than in land-based ICBMs cannot be discounted if the development of substantial hard-target kill capabilities is deliberately undertaken by the U.S. With external guidance aids, we believe that the accuracy of SLBMs can be adequate for hard-target kill capabilities within the Trident missile throw weights. Thus, ICBMs might have to compete with SLBMs for any special counterforce role in the U.S. strategic posture.

We are not sanguine about the competitiveness of the available rebasing options for ICBMs. They are not clearly superior to the SLBMs in survivability, even though they are different in their vulnerabilities. The new basing options are likely to be much more costly than

the present silo basing, possibly as costly as submarine basing. However, if the desired or required counterforce capabilities could be efficiently packaged in a relatively small number of missiles--say one or two hundred--then the cost of the rebased force would be bounded in proportion. A numerically small force would likely require a large missile with many accurate MIRVs, and such a missile may not be compatible with mobile basing concepts that have been proposed.

Equivalence

The concept and precepts of strategic equivalence presently reflect some concerns about strategic posture asymmetries and third-party perceptions. These indicate a special role for ICBMs in the U.S. strategic posture because ICBMs are an important part of the Soviet posture.

If the U.S. wants ICBMs in its strategic force posture so as to look equivalent to the Soviets, then retention of the existing force, which is paid for and relatively inexpensive to maintain, is an attractive option. Given only the political imperatives of matching the Soviets in possession of ICBMs and in aggregate numbers of strategic delivery vehicles, there is no more cost-effective choice than the present Minuteman force.

If the measures of equivalence become more sophisticated and include comparisons of ICBM throw weight, numbers of RVs, accuracy, etc., silo basing will continue to offer cost-effective options for maintaining equivalence. Refitting the present silos with a larger missile, while not cheap, will almost certainly be cheaper than most other means for increasing ballistic missile throw weight.

Thus, the present silo-based ICBM force could continue to be an inexpensive way to maintain equivalence with the Soviet strategic posture. Whether the rationale for equivalence is sufficiently developed and accepted to secure a special role for ICBMs is problematical. If the concerns for the survivability and stability of ICBMs lead to rebasing, then we doubt that the ICBM will continue to enjoy its present substantial cost advantage over other strategic offensive forces. In any event, we believe that the political climate will favor equivalence over stability, and that the economic climate will continue to favor the present silo-based ICBMs over missiles otherwise based.

THE OUTLOOK

We believe there are at least four interesting and unique roles for ICBMs within the U.S. strategic force posture. The first and clearest is specialized capabilities for LSOs provided by improvements in a portion of the present ICBM force. The second is a cost-effective strategic reserve force achieved by dormancy of a portion of the present missiles. This should suffice at least until the Soviets possess a significant hard-target kill capability; after that, any strategic reserve force will require more secure basing than will be afforded by our present ICBM silos.

The third role for ICBMs is that of a limited force with durable high-quality counterforce capability. This role is clouded by lasting concerns about stability and disarming first-strike postures, and by potential competition from SLBMs. Effectiveness in this role does not depend on hard-target kill capability; rather, it depends on a cost-effective and competitive basing scheme that is relatively immune to attack. We have not recognized such a scheme yet.

The fourth role is that of providing ICBM equivalence at low cost. The key here is to retain as much as possible of the present silo basing; other basing schemes surrender the substantial cost advantages of ICBMs over SLBMs and bombers.

We believe that these special roles for ICBMs pose interesting and attractive future alternatives for the U.S. ICBM force, especially when contrasted with the future we see if the ICBMs are denied any special role within the U.S. strategic posture. We have seen no new basing option for ICBMs that would cure their shortcomings without also sacrificing some of their best characteristics. While the search for basing options should proceed, of course, we are persuaded that the future of the U.S. ICBM force should not be predicated--inadvertently or intentionally--on finding a *single* new basing scheme. It might just cost us the entire force, and we think the U.S. strategic posture would be much the worse for the loss.

SECRET

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